VOLUME II

Geotechnical Investigation report of 5X800MW Yadadri thermal Power station at Veerlapalem, Telangana state for Main plant area consists of three volumes as per details given below:

VOLUME –I – Methodology, Analysis & Recommendations

VOLUME – II – Bore logs, Trial pits, field permeability test(Packer test) and laboratory tests results

VOLUME – III – Plate load test,Cyclic plate load test,Cross hole shear test, Pressuremeter test,Block vibration test and Seismic refraction test

This Volume consists of Field Bore logs, Trial pits, field permeability test(Packer Test) and laboratory tests result for proposed power plant.

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Bore/Test no	Northing	Easting	Ground level (G.L.) in terms of RL(+)	Water Table below (G.L.)	Termination depth (m)
BH 1	0	-100	79.603	3	10.0
BH 2	0	-25	81.496	5.5	20.0
BH 3	0	29	81.699	4.5	15.0
BH 4	0	99	82.495	4.00	10.0
BH 5	-69	-112	78.408	3	10.0
BH 6	-69	29	78.761	2.5	10.0
BH 7	-99	-137	78.107	3.5	10.0
BH 8	-99	-71	78.052	3.30	20.0
BH 9	-99	70	78.694	3	20.0
BH 10	-99	136	78.049	-	10.0
BH 11	-126	-22	77.865	2	10.0
BH 12	-126	105	78.447	-	10.0
BH 13	-157	-69	77.753	2.8	20.0
BH 14	-157	71	78.347	-	20.0
BH 15	-191	-105	77.500	2.5	10.0
BH 16	-191	-36	79.707	4.5	10.0
BH 17	-191	36	80.085	-	10.0
BH 18	-191	105	80.011	-	10.0
BH 19	-205	-70	77.474	2.5	15.0
BH 20	-205	70	81.187	4	15.0
BH 21	-220	-144	77.770	2	10.0
BH 22	-232	-104	77.359	2.5	10.0
BH 23	-232	-36	78.126	-	15.0
BH 24	-233	0	79.318	-	10.0
BH 25	-232	36	82.371	-	10.0
BH 26	-232	105	81.759	-	15.0
BH 27	-232	141	82.207	5.3	10.0
BH 28	-263	-74	77.210	2.5	15.0
BH 29	-271	-389	80.715	4	15.0
BH 30	-283	-98	76.958	3.5	15.0
BH 31	-283	-55	77.195	2.8	20.0
BH 32	-283	32	79.000	-	10.0
BH 33	-283	87	79.734	5	20.0
BH 34	-279	135	81.070	5	10.0
BH 35	-302	182	81.078	2.5	15.0
BH 36	-302	-74	76.971	3	15.0
BH 37	-302	68	79.856	4	15.0
BH 38	-329	-3	78.670	6	10.0
BH 39	-330	110	80.260	4.5	10.0
BH 40	-357	-149	76.395	3.90	10.0
BH 41	-356	-88	76.093	2.5	10.0
BH 42	-360	45	78.812	3.60	15.0
BH 43	-369	-5	78.327	3.50	10.0

Bore/Test no	Northing	Easting	Ground level (G.L.) in terms of RL(+)	Water Table below (G.L.)	Termination depth (m)
BH 44	0	334	82.005	-	10.0
BH 45	0	-408	83.598	4.90	10.0
BH 46	0	454	84.067	3.10	20.0
BH 47	0	530	83.363	4.10	10.0
BH 48	0	627	84.008	3.70	15.0
BH 49	0	666	84.354	4.20	20.0
BH 50	-487	1295	84.900		10.0
BH 51	-69	317	80.521	-	15.0
BH 52	-69	454	82.157	3	10.0
BH 53	-69	604	85.112	5.80	15.0
BH 54	-69	711	85.770	4.20	10.0
BH 55	-83	284	80.120	3	10.0
BH 56	-543	1231	84.900	-	15.0
BH 57	-99	361	81.690	3.00	20.0
BH 58	-99	501	83.333		20.0
BH 59	-99	569	84.475	3.90	10.0
BH 60	-99	644	86.233	3.00	20.0
BH 61	-126	406	82.160	3.5	15.0
BH 62	-126	548	84.171	4.30	15.0
BH 63	-126	691	86.090	4.80	15.0
BH 64	-157	362	81.578	3	10.0
BH 65	-157	502	83.770	3.5	15.0
BH 66	157	645	85.885	3.50	20.0
BH 67	-191	327	81.425	3.5	15.0
BH 68	-196	361	82.630	5.5	20.0
BH 69	-191	395	82.540	4	15.0
BH 70	-191	467	83.155	3.5	15.0
BH 71	-191	536	85.365	4.20	15.0
BH 72	-191	610	85.340	-	15.0
BH 73	-191	629	85.731	3.80	9.5
BH 74	-205	501	84.824	3	20.0
BH 75	-205	644	85.487	-	10.0
BH 76	-229	273	82.479	3.5	10.0
BH 77	-232	327	82.160	5	15.0
BH 78	-232	-396	82.520	4	15.0
BH 79	-232	431	82.735	4.5	10.0
BH 80	-232	468	83.262	4.2	15.0
BH 81	-232	536	84.400	-	10.0
BH 82	-235	574	84.900	-	10.0
BH 83	-232	611	85.157	-	10.0
BH 84	-232	679	86.274	-	15.0
BH 85	-241	822	86.254	3.2	10.0
BH 86	-263	358	82.533	4.5	15.0
BH 87	-263	501	84.160	3.80	15.0
BH 88	-263	642	85.222	-	15.0
BH 89	-287	290	82.970	-	10.0
BH 90	-283	334	83.560	4	15.0

Bore/Test no	Northing	Easting	Ground level (G.L.) in terms of RL(+)	Water Table below (G.L.)	Termination depth (m)
BH 91	-283	377	83.106	3	20.0
BH 92	-283	477	82.697	3.5	15.0
BH 93	-283	520	84.460	3.60	7.5
BH 94	-283	618	85.095	3	15.0
BH 95	-283	661	85.390	3	20.0
BH 96	-302	358	83.713	3.2	15.0
BH 97	-302	501	83.987	3	15.0
BH 98	-302	642	85.014	3.5	15.0
BH 99	-330	431	83.842	3	10.0
BH 100	-330	541	84.416	3	10.0
BH 101	-357	341	83.513	3.8	10.0
BH 102	357	479	84.299	3.5	10.0
BH 103	-357	599	84.499	2.5	10.0
BH 104	-350	877	85.572	5	10.0
BH 105	-363	695	85.005	4	10.0
BH 106	-370	423	84.000	-	10.0
BH 107	-370	538	84.375	4	10.0
BH 108	-375	790	85.345	4	15.0
BH 109	908	226	88.560		10.0
BH 110	416	485	87.289		15.0
BH 111	272	472	84.192	4.00	10.0
BH 112	141	644	83.383		10.0
BH 113	-129	-443	82.601	3.80	15.0
BH 114	187	294	79.583	5	10.0
BH 115	-196	-461	82.040	3.80	15.0
BH 116	-214	-529	82.650	4.30	10.0
BH 117	-246	-412	81.215	5	15.0
BH 118	-269	-244	78.400	6.5	15.0
BH 119	-359	-443	80.580	4	15.0
BH 120	-328	-228	79.250	3	15.0
BH 121	-426	-461	79.756	5	15.0
BH 122	-355	-325	79.784	3	10.0
BH 123	-444	-529	79.563	-	10.0
BH 124	-476	-412	80.210	-	15.0
BH 125	-527	-692	81.818	-	15.0
BH 126	-586	-283	76.260	-	10.0
BH 127	-615	-440	76.640	-	10.0
BH 128	-336	1073	86.545	4.50	15.0
BH 129	-404	1055	85.756	4	6.0
BH 130	-422	987	85.187	5.5	10.0
BH 131	-196	361	85.180	5	10.0
BH 132	-468	778	84.301	3	15.0
BH 133	-510,	-18	78.501	3.70	10.0
BH 134	-500	312	79.834	-	10.0
BH 135	-530	428	82.422	-	10.0
BH 136	-532	543	83.328	-	10.0
BH 137	-574	580	81.893	-	10.0

Bore/Test no	Northing	Easting	Ground level (G.L.) in terms of RL(+)	Water Table below (G.L.)	Termination depth (m)
BH 138	-596	19	76.065	4.10	10.0
BH 139	-675	-30	73.623	3.00	10.0
BH 140	-673	57	73.329	3.80	10.0
BH 141	-662	428	79.740	4.20	10.0
BH 142	-665	543	80.602	3.50	10.0
BH 143	-543	-888	83.705	-	10.0
BH 144	-564	1117	84.230	-	10.0
BH 145	-611	870	83.402	-	15.0
BH 146	-629	802	82.342	-	15.0
BH 147	-631	1099	83.822	-	15.0
BH 148	-660	919	83.164	-	10.0
BH 149	-649	1031	83.580	-	10.0
BH 150	-915	1400	81.626	3.50	8.3
BH 151	-681	1148	83.500	-	10.0
BH 152	-830	1155	82.419	-	9.0
BH 153	74	997	87.057	3.50	10.0
BH 154	-113	1200	90.195	3.80	10.0
BH 155	-911	1164	81.867	-	11.0
BH 156	-911	1164	81.116	4.30	9.8
BH 157	-200	1400	87.225	4.50	15.0
BH 158	-1178	1122	79.697	3.20	7.5
BH 159	-961	890	80.537	3.50	6.0
BH 160	-1040	1021	80.977	-	10.0
BH 161	-434	1627	89.075	3.80	15.0
BH 162	-314	1182	87.298	4.10	10.0
BH 163	-1413	1173	76.742	3.90	5.0

BORELOGS

BH NO. :	1	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	79.603
LOCATION :	N = 00, E =-100	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	12/31/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/3/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth (m)	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD) %
0.00	79.60		Highly weathered grey, fine grained Quartzite	0.00							
0.50	78.85			0.75						20	Nil
1.00	78.60										
1.50	78.35			1.25						23	Nil
2.00	77.60		Slightly weathered grey, fine grained Quartzite	2.00						56	16
2.50	77.10		Fresh grey, fine grained Quartzite								
3.00	76.85			2.75						83	63
3.50	75.85			3.75						93	69
4.00	75.60										
4.50	75.10										
5.00	74.60										
5.50	74.35			5.25						71	Nil
6.00	73.60		Fresh black, fine grained shale								
6.50	73.10										
7.00	72.85			6.75						61	Nil
7.50	72.10		Fresh black, fine grained Shale								
8.00	71.60										
8.50	71.35			8.25						73	34
9.00	70.60										
9.50	69.85			9.75						56	29
10.00	69.60			10						72	66

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	2	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	81.496
LOCATION :	N = 00, E = -25	**WATER TABLE below EGL (m) :**	5.50
		CASING Depth (m) :	1.50
START DATE :	1/5/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/10/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.50		Dark Brownish Grey Highly weathered Quartzite								
0.50	80.75			0.75						24	Nil
1.00	80.50		Moderately weathered grey, fine grained Quartzite								
1.50	80.00			1.50						38	38
2.00	79.50										
2.50	79.25			2.25						34	Nil
3.00	78.50			3.00						38	13
3.50	78.00		Fresh grey, fine grained Quartzite								
4.00	77.75			3.75						91	79
4.50	77.00			4.50						95	66
5.00	76.50										
5.50	76.00										
6.00	75.50			6.00						66	25
6.50	75.00		Fresh black, fine grained Shale								
7.00	74.50										
7.50	74.00			7.50						60	Nil
8.00	73.50		Fresh black, fine grained Shale								
8.50	73.00										
9.00	72.50			9.00						73	Nil

BH NO. :	2	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	81.496
LOCATION :	N = 00, E = -25	**WATER TABLE below EGL (m) :**	5.50
		CASING Depth (m) :	1.50
START DATE :	1/5/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/10/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
9.50	72.00		Slightly weathered black, fine grained Shale								
10.00	71.50										
10.50	71.00			10.50						50	Nil
11.00	70.50										
11.50	70.00										
12.00	69.50			12.00						49	Nil
12.50	69.00		Fresh black, fine grained Shale								
13.00	68.50										
13.50	68.00			13.50						71	Nil
14.00	67.50										
14.50	67.00										
15.00	66.50			15.00						80	7
15.50	66.00										
16.00	65.50										
16.50	65.00			16.50						77	58
17.00	64.50										
17.50	64.00										
18.00	63.50			18.00						74	35
18.50	63.00										
19.00	62.50										
19.50	62.00			19.50						73	10
20.00	61.50			20.00						90	20

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	3	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	81.699
LOCATION :	N = 00, E = 29	**WATER TABLE below EGL (m) :**	4.50
		CASING Depth (m) :	1.50
START DATE :	1/14/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/16/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.70		Moderately weathered grey, fine grained Quartzite								
0.50	80.95			0.75						29	Nil
1.00	80.70										
1.50	80.20			1.50						26	Nil
2.00	79.70										
2.50	79.45			2.25						27	Nil
3.00	78.70			3.00						21	Nil
3.50	78.20		Fresh grey, fine grained Quartzite								
4.00	77.95			3.75						85	19
4.50	77.20			4.50						89	61
5.00	76.70		Slightly weathered grey, fine grained Quartzite								
5.50	76.20										
6.00	75.70			6.00						52	20
6.50	75.20										
7.00	74.70										
7.50	74.20			7.50						56	17
8.00	73.70		Slightly weathered grey, fine grained Limestone								
8.50	73.20										
9.00	72.70			9.00						53	Nil
9.50	72.20										
10.00	71.70										
10.50	71.20			10.50						47	Nil
11.00	70.70										
11.50	70.20										
12.00	69.70			12.00						49	7
12.50	69.20		Slightly weathered black, fine grained Shale								
13.00	68.70										
13.50	68.20			13.50						59	Nil
14.00	67.70										
14.50	67.20										
15.00	66.70			15.00						78	44

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	4	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	82.495
LOCATION :	N = 00, E =99	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	NA
START DATE :	3/27/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/28/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.50		Highly weathered grey, fine grained Quartzite	0.00							
0.50	81.75			0.75						21	Nil
1.00	82.50		Moderately weathered grey, fine grained Quartzite								
1.50	81.00			1.50						44	Nil
2.00	80.25			2.25						32	16
2.50	82.50										
3.00	79.50			3.00						29	Nil
3.50	78.75			3.75						64	20
4.00	82.50										
4.50	78.00			4.50						36	14
5.00	82.50		Slightly weathered grey, fine grained Quartzite								
5.50	77.25			5.25						60	49
6.00	76.50			6.00						56	17
6.50	82.50										
7.00	75.75			6.75						52	Nil
7.50	75.00			7.50						53	44
8.00	82.50										
8.50	74.25			8.25						53	36
9.00	73.50			9.00						41	14
9.50	72.75			9.75						31	29
10.00	72.50			10						52	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	5	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.408
LOCATION :	N = -69, E =-112	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	12/26/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/27/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.41		Fine to medium Sandy silt with weathered rock fragments								
0.50	77.91										
1.00	77.41			1.00	SPT1	18	27	31	58		
1.50	76.91			1.50	SPT2	52	>100		R		
2.00	76.41		Slightly weathered grey, fine grained Quartzite			2					
2.50	76.16			2.25						43	23
3.00	75.41			3.00						57	Nil
3.50	74.91		Moderately weathered grey, fine grained Quartzite								
4.00	74.66			3.75						37	35
4.50	73.91			4.50						32	42
5.00	73.41										
5.50	73.16			5.25						25	33
6.00	72.41		Slightly weathered grey, fine grained Quartzite	6.00						54	19
6.50	71.91		Fresh black, fine grained Shale								
7.00	71.66			6.75						97	59
7.50	70.91			7.50						83	18
8.00	70.41										
8.50	69.91										
9.00	69.41			9.00						76	60
9.50	68.91										
10.00	68.41			10.00						75	44

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	6	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.761
LOCATION :	N = -69, E = 29	**WATER TABLE below EGL (m) :**	2.50
		CASING Depth (m) :	1.50
START DATE :	1/11/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/13/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.76		Highly weathered grey, fine grained Quartzite								
0.50	78.26										
1.00	78.01			0.75						23	Nil
1.50	77.26			1.50						23	Nil
2.00	76.76		Moderately weathered grey, fine grained Quartzite								
2.50	76.51			2.25						35	15
3.00	75.76			3.00						41	Nil
3.50	75.26		Fresh grey, fine grained Quartzite								
4.00	75.01			3.75						83	Nil
4.50	74.26			4.50						87	71
5.00	73.76										
5.50	73.26										
6.00	72.76			6.00						74	18
6.50	72.26		Fresh black, fine grained Shale								
7.00	71.76										
7.50	71.26			7.50						75	23
8.00	70.76										
8.50	70.26										
9.00	69.76			9.00						68	27
9.50	69.26										
10.00	68.76			10.00						56	22

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	7	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.107
LOCATION :	N = -99, E = -137	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	12/28/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/30/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.11		Greyish Brownish very stiff Sandy silt								
0.50	77.61										
1.00	77.11			1.00	SPT1	21	22	25	47		
1.50	76.61		Completely weathered Quartzite	1.50	SPT2	52			R		
2.00	76.11		Moderately weathered grey, fine grained Quartzite								
2.50	75.86			2.25						23	Nil
3.00	75.11			3.00						38	15
3.50	74.61		Slighlty weathered grey, fine grained Quartzite								
4.00	74.36			3.75						44	Nil
4.50	73.61			4.50						54	43
5.00	73.11		Fresh grey, fine grained Quartzite								
5.50	72.86			5.25						80	15
6.00	72.11			6.00						86	51
6.50	71.61										
7.00	71.11										
7.50	70.61			7.50						65	30
8.00	70.11		Fresh black, fine grained Shale								
8.50	69.61										
9.00	69.11			9.00						74	45
9.50	68.61										
10.00	68.11			10.00						63	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	8	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.052
LOCATION :	N = -99, E = -71	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	12/28/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/4/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.05		Completely weathered grey, fine grained Quartzite								
0.50	77.55										
1.00	77.30			0.75	SPT1	52	>50	>50		R	
1.50	76.55		Moderately weathered grey, fine grained Quartzite	1.50						24	Nil
2.00	76.05										
2.50	75.80			2.25						30	Nil
3.00	75.05			3.00						29	Nil
3.50	74.55										
4.00	74.30			3.75						33	Nil
4.50	73.55		Fresh grey, fine grained Quartzite	4.50						91	44
5.00	73.05										
5.50	72.80			5.25						86	75
6.00	72.05										
6.50	71.30			6.75						79	25
7.00	71.05		Moderately weathered black, fine grained Shale								
7.50	70.55			7.50							
8.00	70.05										
8.50	69.80			8.25						40	Nil

BH NO. :	8	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.052
LOCATION :	N = -99, E = -71	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	12/28/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/4/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
9.00	69.05		Fresh black, fine grained Shale								
9.50	68.30			9.75						78	26
10.00	68.05										
10.50	67.55										
11.00	67.05										
11.50	66.80			11.25						69	10
12.00	66.05										
12.50	65.55										
13.00	65.30			12.75						72	39
13.50	64.55										
14.00	64.05										
14.50	63.80			14.25						82	31
15.00	63.05										
15.50	62.55										
16.00	62.30			15.75						89	65
16.50	61.55										
17.00	61.05										
17.50	60.80			17.25						79	38
18.00	60.05										
18.50	59.55										
19.00	59.30			18.75						81	39
19.50	58.55										
20.00	58.05			20.00						80	66

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	9	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.694
LOCATION :	N = -99, E = 70	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	12/18/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/21/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.69										
0.50	78.19		Highly weathered grey, fine grained Quartzite								
1.00	77.94			0.75						25	Nil
1.50	77.19			1.50						24	Nil
2.00	76.69										
2.50	76.44			2.25						91	15
3.00	75.69			3.00						90	Nil
3.50	75.19										
4.00	74.69		Fresh grey, fine grained Quartzite								
4.50	74.19			4.50						61	40
5.00	73.69										
5.50	73.19										
6.00	72.69			6.00						73	25
6.50	72.19										
7.00	71.69										
7.50	71.19		Fresh grey, fine grained limestone	7.50						79	Nil
8.00	70.69										
8.50	70.19										
9.00	69.69			9.00						74	Nil

BH NO. :	9	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.694
LOCATION :	N = -99, E = 70	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	12/18/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/21/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
9.50	69.19		Fresh black, fine grained Shale								
10.00	68.69										
10.50	68.19			10.50						67	28
11.00	67.69										
11.50	67.19										
12.00	66.69			12.00						77	9
12.50	66.19										
13.00	65.69										
13.50	65.19			13.50						72	32
14.00	64.69										
14.50	64.19										
15.00	63.69			15.00						78	40
15.50	63.19										
16.00	62.69										
16.50	62.19			16.50						76	43
17.00	61.69										
17.50	61.19										
18.00	60.69			18.00						75	44
18.50	60.19										
19.00	59.69										
19.50	59.19			19.50						92	76
20.00	58.69			20.00						49	49

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	10	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.049
LOCATION :	N = -99, E = 136	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	12/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/14/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.05		Completely weathered grey, fine grained Quartzite								
0.50	77.55										
1.00	77.05			1.00	SPT1	>50	>50	>50	R		
1.50	76.55		Highly weathered grey, fine grained Quartzite	1.50						24	Nil
2.00	76.05		Moderately weathered grey, fine grained Fractured Quartzite								
2.50	75.80			2.25						45	16
3.00	75.05		Fresh black, fine grained Fractured Shale	3.00						86	49
3.50	74.55										
4.00	74.30			3.75						81	38
4.50	73.55										
5.00	73.05										
5.50	72.80			5.25						64	19
6.00	72.05										
6.50	71.55										
7.00	71.30			6.75						67	26
7.50	70.55										
8.00	70.05										
8.50	69.80			8.25						77	9
9.00	69.05										
9.50	68.80			9.25						73	47
10.00	68.05			10.00						82	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	11	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	77.865
LOCATION :	N = -126, E = -22	**WATER TABLE below EGL (m) :**	2.00
		CASING Depth (m) :	1.50
START DATE :	12/26/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/27/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	77.87		Moderately weathered grey, fine grained Limestone								
0.50	77.37										
1.00	77.12			0.75						28	Nil
1.50	76.37			1.50						36	Nil
2.00	75.87										
2.50	75.62		Moderately grey, fine grained Quartzite	2.25						29	Nil
3.00	74.87			3.00						41	Nil
3.50	74.37		Fresh grey, fine grained Quartzite								
4.00	74.12			3.75						85	13
4.50	73.37			4.50						93	77
5.00	72.87										
5.50	72.37										
6.00	71.87			6.00						57	55
6.50	71.37										
7.00	70.87										
7.50	70.37			7.50						64	49
8.00	69.87		Fresh black, fine grained Shale								
8.50	69.37										
9.00	68.87			9.00						71	33
9.50	68.37										
10.00	67.87			10.00						83	76

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	12	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.447
LOCATION :	N = -126, E = 105	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	12/15/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/17/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.45		Completely weathered rock								
0.50	77.95					10					
1.00	77.70			0.75	SPT1	52	>100		R		
1.50	76.95			1.50	SPT2	52	>100		R		
2.00	76.45		Fresh grey, fine grained Quartzite								
2.50	76.20			2.25						83	16
3.00	75.45			3.00						81	28
3.50	74.95		Fresh grey, fine grained Fractured Quartzite								
4.00	74.45										
4.50	73.95			4.50						74	51
5.00	73.45										
5.50	72.95										
6.00	72.45			6.00						63	23
6.50	71.95										
7.00	71.45										
7.50	70.95			7.50						51	17
8.00	70.45										
8.50	69.95										
9.00	69.45			9.00						84	58
9.50	68.95										
10.00	68.45			10.00						73	21

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	13	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	77.753
LOCATION :	N = -157, E = -69	**WATER TABLE below EGL (m) :**	2.80
		CASING Depth (m) :	1.50
START DATE :	12/22/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/24/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	77.75		Highly weathered grey, fine grained, Fractured Quartzite								
0.50	77.25										
1.00	77.00			0.75						23	Nil
1.50	76.25		Moderately weathered grey, fine grained, Fractured Limestone	1.50						32	Nil
2.00	75.75										
2.50	75.50			2.25						27	Nil
3.00	74.75		Fresh grey, fine grained, Fractured Quartzite	3.00						64	49
3.50	74.25										
4.00	74.00			3.75						83	36
4.50	73.25			4.50						85	14
5.00	72.75										
5.50	72.25										
6.00	71.75			6.00						86	34
6.50	71.25										
7.00	70.75										
7.50	70.25			7.50						78	15

BH NO. :	13	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	77.753
LOCATION :	N = -157, E = -69	**WATER TABLE below EGL (m) :**	2.80
		CASING Depth (m) :	1.50
START DATE :	12/22/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/24/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
8.00	69.75		Fresh black, fine grained Fractured Shale								
8.50	69.25										
9.00	68.75			9.00						85	7
9.50	68.25										
10.00	67.75										
10.50	67.25			10.50						84	7
11.00	66.75										
11.50	66.25										
12.00	65.75			12.00						82	29
12.50	65.25										
13.00	64.25			13.50						86	36
13.50	64.25										
14.00	63.75										
14.50	63.25										
15.00	62.75			15.00						75	26
15.50	62.25										
16.00	61.75										
16.50	61.25										
17.00	61.00			16.75						88	7
17.50	59.75			18.00						77	Nil
18.00	59.75										
18.50	59.25										
19.00	58.25			19.50						85	39
19.50	58.25										
20.00	57.75			20.00						83	23

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	14	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	78.347
LOCATION :	N = -157, E = 71	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	0.75
START DATE :	12/22/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/24/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.35		Completely weathered brown, fine grained rock								
0.50	77.85										
1.00	77.60			0.75						2	Nil
1.50	76.85		Fresh grey, fine grained Quartzite	1.50						84	67
2.00	76.35										
2.50	76.10			2.25						96	88
3.00	75.35		Fresh grey, fine grained, Fractured Quartzite								
3.50	74.85										
4.00	74.60			3.75						75	36
4.50	73.85										
5.00	73.35										
5.50	73.10			5.25						85	47
6.00	72.35										
6.50	71.85										
7.00	71.60			6.75						59	45
7.50	70.85										
8.00	70.35										
8.50	70.10			8.25						79	71

BH NO. :	14	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	78.347
LOCATION :	N = -157, E = 71	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	0.75
START DATE :	12/22/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/24/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	Penetration, cm 30	Penetration, cm 45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
9.00	69.35		Fresh grey, fine grained Fractured Quartzite								
9.50	68.85										
10.00	68.60			9.75						76	Nil
10.50	67.85										
11.00	67.35										
11.50	67.10			11.25						62	30
12.00	66.35										
12.50	65.85										
13.00	65.60			12.75						89	56
13.50	64.85										
14.00	64.35										
14.50	64.10			14.25						95	21
15.00	63.35										
15.50	62.85										
16.00	62.60			15.75						54	42
16.50	61.85										
17.00	61.35										
17.50	61.10			17.25						46	46
18.00	60.35										
18.50	59.85										
19.00	59.60			18.75						52	47
19.50	58.85										
20.00	58.35			20.00						83	23

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	15	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	77.500
LOCATION :	N = -191, E = -105	**WATER TABLE below EGL (m) :**	2.50
		CASING Depth (m) :	1.50
START DATE :	12/29/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/2/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	77.50		Dense Dark Grey Sandy silt								
0.50	77.00										
1.00	76.75			0.75	SPT1	8	14	28	42		
1.50	76.00		Completely weathered Rock	1.50	SPT2	52	R		R		
2.00	75.50		Moderately weathered grey, fine grained Limestone								
2.50	75.25			2.25						33	Nil
3.00	74.50		Fresh grey, fine grained Limestone	3.00						93	Nil
3.50	74.00										
4.00	73.75			3.75						32	Nil
4.50	73.00		Fresh grey, fine grained Quartzite	4.50						59	Nil
5.00	72.50										
5.50	72.25			5.25						86	28
6.00	71.50			6.00						99	31
6.50	71.00										
7.00	70.50										
7.50	70.00			7.50						48	Nil
8.00	69.50										
8.50	69.00										
9.00	68.50			9.00						67	44
9.50	68.00										
10.00	67.75			9.75						80	54

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	16	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	79.707
LOCATION :	N = -191, E = -36	**WATER TABLE below EGL (m) :**	4.50
		CASING Depth (m) :	1.50
START DATE :	1/5/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/6/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.71		Moderately weathered grey, fine grained Limestone								
0.50	79.21										
1.00	78.96			0.75						29	Nil
1.50	78.21		Slightly weathered Rock	1.50						51	Nil
2.00	77.71		Fresh grey, fine grained Limestone								
2.50	77.46			2.25						91	Nil
3.00	76.71			3.00						84	23
3.50	76.21										
4.00	75.71										
4.50	75.21			4.50						71	16
5.00	74.71										
5.50	74.21										
6.00	73.71			6.00						65	Nil
6.50	73.21										
7.00	72.71										
7.50	72.21			7.50						69	15
8.00	71.71										
8.50	71.21										
9.00	70.71			9.00						75	68
9.50	70.21										
10.00	69.96			9.75						74	64

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	17	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	80.085
LOCATION :	N = -191, E = 36	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	3.00
START DATE :	12/10/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth m	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD) %
0.00	80.09		Fresh grey, fine grained Limestone								
0.50	79.59										
1.00	79.34			0.75						81	Nil
1.50	78.59		Fresh grey, fine grained Quartzite with Conglomerate	1.50						87	31
2.00	78.09										
2.50	77.59										
3.00	77.09			3.00						96	40
3.50	76.59		Fresh grey, fine grained Fractured Quartzite								
4.00	76.09										
4.50	75.59			4.50						71	47
5.00	75.09										
5.50	74.59										
6.00	74.09			6.00						71	32
6.50	73.59										
7.00	73.09										
7.50	72.59			7.50						63	Nil
8.00	72.09										
8.50	71.59										
9.00	71.09			9.00						61	16
9.50	70.59		Fresh black, fine grained, Fractured Shale								
10.00	70.34			9.75						69	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	18	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	80.011
LOCATION :	N = -191, E = 105	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	12/5/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/7/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	80.01		Yellowish Completely weathered rock								
0.50	79.51										
1.00	79.26			0.75	SPT1	32	51	>100		R	
1.50	78.51			1.50	SPT2	39	50	>100		R	
2.00	78.01		Moderately weathered grey, fine grained, fractured Limestone								
2.50	77.76			2.25						25	Nil
3.00	77.01			3.00						39	Nil
3.50	76.51		Slightly weathered red, fine grained, Fractured Sandstone								
4.00	76.26			3.75						51	29
4.50	75.51			4.50						59	13
5.00	75.01		Fresh red, fine grained, Fractured Sandstone								
5.50	74.76			5.25						96	35
6.00	74.01			6.00						57	13
6.50	73.51										
7.00	73.26			6.75						67	Nil
7.50	72.51			7.50						67	Nil
8.00	72.01		Fresh black, fine grained, Fractured Shale								
8.50	71.76			8.25						66	Nil
9.00	71.01			9.00						67	Nil
9.50	70.51										
10.00	70.26			9.75						77	11

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	19	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	77.474
LOCATION :	N = -205, E = -70	**WATER TABLE below EGL (m) :**	2.50
		CASING Depth (m) :	1.50
START DATE :	12/24/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/28/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	Penetration, cm 30	Penetration, cm 45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
0.00	77.47		Completely weathered, brown rock								
0.50	76.97					7					
1.00	76.72			0.75	SPT1	52				R	
1.50	75.97		Moderately weathered grey, fine grained Limestone	1.50						34	Nil
2.00	75.47		Fresh grey, fine grained Limestone								
2.50	75.22			2.25						84	13
3.00	74.72			2.75						90	28
3.50	73.97										
4.00	73.47										
4.50	72.97			4.50						73	15
5.00	72.47		Fresh grey, fine grained Quartzite								
5.50	71.97										
6.00	71.72			5.75						67	Nil
6.50	70.97										
7.00	70.47										
7.50	69.97			7.50						77	27
8.00	69.47										
8.50	77.47										
9.00	68.47			9.00						59	14
9.50	67.97										
10.00	67.47										
10.50	66.97		Fresh black, fine grained Shale	10.50						67	26
11.00	66.47										
11.50	65.97										
12.00	65.47			12.00						66	Nil
12.50	64.97										
13.00	64.47										
13.50	63.97			13.50						75	31
14.00	63.47										
14.50	62.97										
15.00	62.47			15.00						80	39

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	20	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	81.19
LOCATION :	N = -205, E = 70	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	3.00
START DATE :	12/1/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/4/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.19		Completely weathered, brown rock								
0.50	80.69					7					
1.00	80.44			0.75	SPT1	34	50	>100		R	
1.50	79.69			1.50	SPT2	50	>100			R	
2.00	79.19										
2.50	78.94			2.25	SPT3	>100				R	
3.00	78.44			2.75	SPT4	>100				R	
3.50	77.69		Fresh grey, fine grained Quartzite								
4.00	77.44			3.75						63	13
4.50	76.69			4.50						43	Nil
5.00	76.19										
5.50	75.94			5.25						57	20
6.00	75.19			6.00						49	24
6.50	74.69										
7.00	74.44			6.75						67	43
7.50	73.69			7.50						62	20
8.00	73.19										
8.50	72.94			8.25						73	37
9.00	72.19			9.00						89	24
9.50	71.69										
10.00	71.44			9.75						79	37
10.50	70.69		Fresh grey, fine grained Basalt	10.50						95	67
11.00	70.19										
11.50	69.94			11.25						81	32
12.00	69.19										
12.50	68.69										
13.00	68.44			12.75						42	23
13.50	67.69										
14.00	67.19										
14.50	66.94			14.25						65	42
15.00	66.19			15.00						100	100

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	21	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	77.770
LOCATION :	N = -220, E = -144	**WATER TABLE below EGL (m) :**	2.00
		CASING Depth (m) :	1.50
START DATE :	12/26/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/28/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	77.77		Very Stiff Sandy silt								
0.50	77.27										
1.00	77.02			0.75	SPT1	12	17	28	45		
1.50	76.27		Brownish Completely weathered rock	1.50	SPT2	52	>50	>50	R		
2.00	75.77		Slightly weathered grey, fine grained Limestone								
2.50	75.52			2.25						52	Nil
3.00	75.02			2.75						35	Nil
3.50	74.27										
4.00	74.02			3.75						51	Nil
4.50	73.27		Fresh grey, fine grained Quartzite	4.50						50	18
5.00	72.77										
5.50	72.52			5.25						91	25
6.00	71.77			6.00						83	59
6.50	71.27										
7.00	70.77										
7.50	70.27			7.50						76	42
8.00	69.77		Fresh black, fine grained Shale								
8.50	69.27										
9.00	68.77			9.00						66	27
9.50	68.27										
10.00	68.02			9.75						80	51

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	22	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	77.359
LOCATION :	N = -232, E = -104	**WATER TABLE below EGL (m) :**	2.50
		CASING Depth (m) :	1.50
START DATE :	12/23/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/25/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	77.36		Sandy silt with Gravels								
0.50	76.86										
1.00	76.61			0.75	SPT1	52	>100		R		
1.50	75.86		Highly weathered grey, fine grained Limestone	1.50						24	Nil
2.00	75.36										
2.50	75.11			2.25						25	Nil
3.00	74.36		Slightly weathered grey, fine grained Limestone	3.00						37	Nil
3.50	73.86										
4.00	73.61			3.75						43	Nil
4.50	72.86		Fresh grey, fine grained Quartzite	4.50						85	13
5.00	72.36										
5.50	72.11			5.25						89	15
6.00	71.36										
6.50	70.86										
7.00	70.61			6.75						71	52
7.50	69.86										
8.00	69.36										
8.50	69.11			8.25						58	18
9.00	68.36		Fresh black, fine grained Shale								
9.50	67.61			9.75						71	8
10.00	67.36			10.00						64	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	23	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	78.126
LOCATION :	N = -232, E = -36	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	12/15/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/17/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
0.00	78.13		Completely brown weathered rock								
0.50	77.63										
1.00	77.38			0.75	SPT1	52	>100		R		
1.50	76.63		Moderately weathered grey, fine grained Quartzite	1.50						37	Nil
2.00	76.13		Fresh grey, fine grained Quartzite								
2.50	75.88			2.25						83	Nil
3.00	75.38			2.75						80	Nil
3.50	74.63										
4.00	74.13										
4.50	73.63			4.50						64	23
5.00	73.13										
5.50	72.63										
6.00	72.13			6.00						64	15
6.50	71.63										
7.00	71.13										
7.50	70.63			7.50						60	23
8.00	70.13										
8.50	69.63										
9.00	69.13			9.00						69	9
9.50	68.63										
10.00	68.13										
10.50	67.63			10.50						70	19
11.00	67.13										
11.50	66.63										
12.00	66.38			11.75						49	Nil
12.50	65.63										
13.00	65.13										
13.50	64.63			13.50						61	52
14.00	64.13										
14.50	63.63										
15.00	63.13			15.00						70	33

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	24	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	79.318
LOCATION :	N = -233, E = 00	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	12/13/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/14/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.32		Completely weathered, grey, fine grained Limestone								
0.50	78.82										
1.00	78.57			0.75	SPT1	52	>100			R	
1.50	77.82		Moderately weathered grey, fine grained Limestone	1.50						31	Nil
2.00	77.32		Fresh brownish grey, fine grained Limestone								
2.50	77.07			2.25						83	Nil
3.00	76.32			3.00						80	15
3.50	75.82		Slightly weathered greyish white, fine grained Quartzite								
4.00	75.32										
4.50	74.82			4.50						57	26
5.00	74.32		Fresh greyish white, fine grained Quartzite								
5.50	73.82										
6.00	73.32			6.00						75	73
6.50	72.82										
7.00	72.32										
7.50	71.82			7.50						82	28
8.00	71.32										
8.50	70.82										
9.00	70.32			9.00						77	68
9.50	69.82		Fresh black, fine grained Shale								
10.00	69.32			10.00						84	61

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	25	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.371
LOCATION :	N = -232, E = 36	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	3.00
START DATE :	11/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/13/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.37		Completely weathered brown Limestone								
0.50	81.87										
1.00	81.62			0.75	SPT1	52	>100		R		
1.50	80.87		Moderately weathered Limestone	1.50						33	Nil
2.00	80.37		Fresh grey, fine grained Limestone								
2.50	80.12			2.25						89	Nil
3.00	79.37			3.00						83	Nil
3.50	78.87		Fresh grey, fine grained Quartzite								
4.00	78.37										
4.50	77.87			4.50						68	8
5.00	77.37										
5.50	76.87										
6.00	76.37			6.00						60	Nil
6.50	75.87										
7.00	75.37										
7.50	74.87			7.50						76	76
8.00	74.37										
8.50	73.87										
9.00	73.37			9.00						84	43
9.50	72.87										
10.00	72.37			10.00						73	26

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	26	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.207
LOCATION :	N = -232, E = 105	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	3.00
START DATE :	7/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	10/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth m	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD) %
0.00	82.21		Completely weathered brown Limestone								
0.50	81.71										
1.00	81.46			0.75	SPT1	50	53	55	R		
1.50	80.71			1.50	SPT2	>100			R		
2.00	80.21		Fresh grey, fine grained Limestone								
2.50	79.96			2.25						67	Nil
3.00	79.21		Completely weathered grey, fine grained Limestone	3.00		>100			R		
3.50	78.71		Fresh grey, fine grained Fractured Limestone								
4.00	78.46			3.75						85	23
4.50	77.71			4.50						82	37
5.00	77.21		Fresh red, fine grained Fractured Sandstone								
5.50	76.71										
6.00	76.21			6.00						72	26
6.50	75.71										
7.00	75.21										
7.50	74.71			7.50						41	17
8.00	74.21		Fresh grey, fine grained Fractured Quartzite								
8.50	73.71										
9.00	73.21			9.00						64	35
9.50	72.71										
10.00	72.21										
10.50	71.71			10.50						70	44
11.00	71.21		Fresh black, fine grained Fractured Shale								
11.50	70.71										
12.00	70.46			11.75						66	14
12.50	69.71										
13.00	69.21										
13.50	68.71			13.50						86	19
14.00	68.21										
14.50	67.71										
15.00	67.21			15.00						75	47

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	27	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	77.210
LOCATION :	N = -232, E = 141	**WATER TABLE below EGL (m) :**	5.30
		CASING Depth (m) :	2.00
START DATE :	12/22/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/1/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	77.21		Moderately weathered grey, fine grained Limestone								
0.50	76.71										
1.00	76.46			0.75						28	Nil
1.50	75.71		Fresh grey, fine grained Limestone	1.50						87	19
2.00	75.21										
2.50	74.96			2.25						83	Nil
3.00	74.21		Moderately weathered grey, fine grained Limestone								
3.50	73.71			3.50						45	Nil
4.00	73.21		Slightly weathered grey, fine grained Limestone								
4.50	72.71										
5.00	72.21										
5.50	71.96			5.25						59	7
6.00	71.21		Fresh grey, fine grained Quartzite								
6.50	70.71										
7.00	70.46			6.75						87	75
7.50	69.71										
8.00	69.21										
8.50	68.96			8.25						87	32
9.00	68.21										
9.50	67.46			9.75						53	34
10.00	67.21			10.00						76	48

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	27	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	77.210
LOCATION :	N = -232, E = 141	**WATER TABLE below EGL (m) :**	5.30
		CASING Depth (m) :	2.00
START DATE :	12/22/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/1/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	77.21		Moderately weathered grey, fine grained Limestone								
0.50	76.71										
1.00	76.46			0.75						28	Nil
1.50	75.71		Fresh grey, fine grained Limestone	1.50						87	19
2.00	75.21										
2.50	74.96			2.25						83	Nil
3.00	74.21		Moderately weathered grey, fine grained Limestone								
3.50	73.71			3.50						45	Nil
4.00	73.21		Slightly weathered grey, fine grained Limestone								
4.50	72.71										
5.00	72.21										
5.50	71.96			5.25						59	7
6.00	71.21		Fresh grey, fine grained Quartzite								
6.50	70.71										
7.00	70.46			6.75						87	75
7.50	69.71										
8.00	69.21										
8.50	68.96			8.25						87	32
9.00	68.21										
9.50	67.46			9.75						53	34
10.00	67.21			10.00						76	48

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	28	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	80.715
LOCATION :	N = -263, E = -74	**WATER TABLE below EGL (m) :**	2.50
		CASING Depth (m) :	1.50
START DATE :	12/28/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/1/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	80.72		Dark Brown very stiff Sandy silt								
0.50	80.22										
1.00	79.97			0.75	SPT1	12	52	>50	R		
1.50	79.22		Completely Weathered grey, fine garined Quartzite	1.50	SPT2	52			R		
2.00	78.72		Moderately weathered grey, fine grained Quartzite								
2.50	78.47			2.25						26	Nil
3.00	77.72			3.00						33	Nil
3.50	77.22		Slightly weathered grey, fine grained Quartzite								
4.00	76.97			3.75						43	43
4.50	76.22		Fresh grey, fine grained Quartzite	4.50						85	40
5.00	75.72										
5.50	75.47			5.25						81	14
6.00	74.72										
6.50	74.22										
7.00	73.72										
7.50	73.22										
8.00	72.72										
8.50	72.22										
9.00	71.72		Fresh dark grey, fine grained Shale								
9.50	71.22										
10.00	70.72			10.00						76	48
10.50	70.22										
11.00	69.72										
11.50	69.47			11.25						77	Nil
12.00	68.72										
12.50	68.22										
13.00	67.97			12.75						76	19
13.50	67.22										
14.00	66.72										
14.50	66.47			14.25						71	27
15.00	65.72			15.00						75	47

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	29	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	76.958
LOCATION :	N = -263, E = 68	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	7/1/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/1/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	76.96		Completely weathered grey, fine grained Limestone								
0.50	76.46			0.75						24	Nil
1.00	76.96		Slightly weathered grey, fine grained Limestone								
1.50	75.71			1.25						45	Nil
2.00	74.96		Moderately weathered grey, fine grained Limestone								
2.50	74.71			2.25						39	Nil
3.00	73.96			3.00						35	Nil
3.50	73.46										
4.00	73.21			3.75						30	Nil
4.50	72.46			4.50						37	14
5.00	71.96										
5.50	71.71			5.25						33	Nil
6.00	70.96		Fresh grey, fine grained Limestone	6.00						84	75
6.50	70.46										
7.00	70.21			6.75						82	45
7.50	69.46										
8.00	68.96										
8.50	68.71			8.25						68	58
9.00	67.96										
9.50	67.46										
10.00	66.96			10.00						67	43
10.50	66.46										
11.00	65.96										
11.50	65.71			11.25						68	22
12.00	64.96		Fresh black, fine grained Shale								
12.50	64.46										
13.00	64.21			12.75						71	Nil
13.50	63.46										
14.00	62.96										
14.50	62.71			14.25						72	Nil
15.00	61.96			15.00						65	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	30	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	77.195
LOCATION :	N = -283, E = -98	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	12/18/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/20/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	77.20		Highly weathered grey, fine grained Quartzite								
0.50	76.45			0.75						21	Nil
1.00	76.20		Moderately weathered Fractured grey, fine grained Quartzite								
1.50	75.70			1.50						25	Nil
2.00	75.20										
2.50	74.95			2.25						38	Nil
3.00	74.20		Slightly weathered grey, fine grained Quartzite	3.00						66	Nil
3.50	73.70										
4.00	73.45			3.75						57	17
4.50	72.70			4.50						60	29
5.00	72.20		Fresh grey, fine grained Quartzite								
5.50	71.95			5.25						88	76
6.00	71.20			6.00						87	47
6.50	70.70										
7.00	70.20										
7.50	69.70			7.50						62	26
8.00	69.20		Fresh dark greyish black, fine grained Shale								
8.50	68.70										
9.00	68.20			9.00						97	Nil
9.50	67.70										
10.00	67.20										
10.50	66.70			10.50						41	Nil
11.00	66.20										
11.50	65.70										
12.00	65.20			12.00						46	18
12.50	64.70										
13.00	64.20										
13.50	63.70			13.50						63	55
14.00	63.20										
14.50	62.70										
15.00	62.20			15.00						63	23

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	31	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	79.000
LOCATION :	N = -283, E = -55	**WATER TABLE below EGL (m) :**	2.80
		CASING Depth (m) :	1.50
START DATE :	12/21/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/24/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.00		Highly weathered grey, fine grained Quartzite								
0.50	78.25			0.75						21	Nil
1.00	78.00		Moderately weathered grey, fine grained Quartzite								
1.50	77.50			1.50						37	Nil
2.00	77.00										
2.50	76.75			2.25						29	Nil
3.00	76.00			3.00						29	Nil
3.50	75.50		Fresh grey, fine grained Quartzite								
4.00	75.25			3.75						93	30
4.50	74.50			4.50						86	37
5.00	74.00										
5.50	73.50										
6.00	73.25			5.75						63	26
6.50	72.50										
7.00	72.00										
7.50	71.50			7.50						74	17
8.00	71.00		Fresh dark greyish black, fine grained Shale								
8.50	70.50										
9.00	70.00			9.00						62	Nil
9.50	69.50										
10.00	69.00										

BH NO. :	31	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	79.000
LOCATION :	N = -283, E = -55	**WATER TABLE below EGL (m) :**	2.80
		CASING Depth (m) :	1.50
START DATE :	12/21/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/24/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
10.50	68.50		Fresh dark greyish black,fine grained Shale	10.50						71	22
11.00	68.00										
11.50	67.50										
12.00	67.00			12.00						66	7
12.50	66.50		Fresh dark greyish black,fine grained Shale								
13.00	66.00										
13.50	65.50			13.50						74	22
14.00	65.00										
14.50	64.50										
15.00	64.00			15.00						66	31
15.50	63.50										
16.00	63.00										
16.50	62.50			16.50						79	58
17.00	62.00										
17.50	61.50										
18.00	61.00			18.00						79	32
18.50	60.50										
19.00	60.00										
19.50	59.50			19.50						85	39
20.00	59.00			20.00						67	20

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	32	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	79.734
LOCATION :	N= -283 E= 43	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	1/15/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/18/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.73										
0.50	79.23										
1.00	78.98			0.75						32	Nil
1.50	78.23		Moderately Weathered grey, fine grained Quartzite	1.50						22	Nil
2.00	77.73										
2.50	77.48			2.25						37	16
3.00	76.73			3.00						25	20
3.50	76.23										
4.00	75.98			3.75						80	48
4.50	75.23		Fresh grey, fine grained Quartzite	4.50						80	Nil
5.00	74.73										
5.50	74.23										
6.00	73.73			6.00						72	22
6.50	73.23										
7.00	72.73		Slightly Weathered grey, fine grained Limestone								
7.50	72.23			7.50						50	Nil
8.00	71.73										
8.50	71.23		Fresh grey, fine grained Limestone								
9.00	70.73			9.00						68	20
9.50	70.23										
10.00	69.73		Slightly Weathered grey, fine grained Limestone								
10.50	69.23			10.50						56	21
11.00	68.73										
11.50	68.23		Fresh grey, fine grained Limestone								
12.00	67.73			12.00						64	44
12.50	67.23										
13.00	66.73		Slightly Weathered grey, fine grained Limestone								
13.50	66.23			13.50						45	10
14.00	65.73										
14.50	65.23		Fresh grey, fine grained Limestone								
15.00	64.73			15.00						64	20

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	33	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	81.070
LOCATION :	N = -283, E = 87	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	1/7/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/12/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.07		Moderately weathered grey, fine grained Limestone								
0.50	80.32			0.75						30	Nil
1.00	80.07										
1.50	79.57			1.50						37	Nil
2.00	79.07										
2.50	78.82			2.25						25	Nil
3.00	78.07		Moderately weathered grey, fine grained Quartzite	3.00						29	Nil
3.50	77.57										
4.00	77.32			3.75						23	Nil
4.50	76.57			4.50						33	Nil
5.00	76.07		Slightly weathered grey, fine grained Quartzite								
5.50	75.82			5.25						45	18
6.00	75.07			6.00						39	Nil
6.50	74.57										
7.00	74.32			6.75						50	18
7.50	73.57		Fresh dark grey, fine grained Quartzite	7.50						81	47
8.00	73.07										
8.50	72.82			8.25						92	72
9.00	72.07										
9.50	71.57										
10.00	71.32			9.75						65	14

BH NO. :	33	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	81.070
LOCATION :	N = -283, E = 87	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	1/7/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/12/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
10.50	70.57		Fresh black, fine grained Shale								
11.00	70.07										
11.50	69.82			11.25						75	8
12.00	69.07										
12.50	68.57										
13.00	68.32			12.75						78	31
13.50	67.57										
14.00	67.07										
14.50	66.82			14.25						72	17
15.00	66.07										
15.50	65.57										
16.00	65.50			15.57						79	52
16.50	64.57										
17.00	64.07										
17.50	63.82			17.25						77	50
18.00	63.07										
18.50	62.57										
19.00	62.32			18.75						68	42
19.50	61.57										
20.00	61.07			20.00						52	Nil

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	34	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	81.078
LOCATION :	N = -279, E =135	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	1/4/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/6/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.08										
0.50	80.33			0.75						25	Nil
1.00	80.08										
1.50	79.58		Highly weathered greyish brown , fine grained Limestone	1.50						23	Nil
2.00	79.08										
2.50	78.83			2.25						24	Nil
3.00	78.08			3.00						21	Nil
3.50	77.58										
4.00	77.33			3.75						22	Nil
4.50	76.58			4.50						81	51
5.00	76.08										
5.50	75.83			5.25						80	40
6.00	75.08										
6.50	74.58										
7.00	74.33		Fresh grey, fine grained Quartzite	6.75						66	27
7.50	73.58										
8.00	73.08										
8.50	72.83			8.25						77	39
9.00	72.08										
9.50	71.33			9.75						81	81
10.00	71.33			9.75						74	74

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	35	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	76.971
LOCATION :	N = -283 E = 182	**WATER TABLE below EGL (m) :**	2.50
		CASING Depth (m) :	1.50
START DATE :	2/22/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/23/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	76.97		Moderately Weathered,Fractured grey, fine grained Quartzite								
0.50	76.47										
1.00	76.22			0.75						35	35
1.50	75.47		Moderately Weathered grey, fine grained Quartzite	1.50						31	Nil
2.00	74.97										
2.50	74.72			2.25						32	Nil
3.00	73.97			3.00						61	35
3.50	73.47										
4.00	73.22			3.75						33	Nil
4.50	72.47			4.50						29	Nil
5.00	71.97		Fresh grey, fine grained Quartzite								
5.50	71.72			5.25						82	37
6.00	70.97			6.00						91	79
6.50	70.47										
7.00	69.97										
7.50	69.47			7.50						58	58
8.00	68.97										
8.50	68.47										
9.00	67.97			9.00						73	27
9.50	67.47										
10.00	66.97										
10.50	66.47			10.50						66	9
11.00	65.97										
11.50	65.47										
12.00	64.97			12.00						49	13
12.50	64.47										
13.00	63.97										
13.50	63.47										
14.00	63.47			13.50						56	23
14.50	62.47										
15.00	61.97			15.00						81	15

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	36	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	79.856
LOCATION :	N = -302, E = -74	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/14/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/16/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	Penetration, cm 30	Penetration, cm 45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
0.00	79.86		Highly weathered grey, fine grained Quartzite								
0.50	79.11			0.75						24	Nil
1.00	78.86										
1.50	78.36			1.50						23	23
2.00	77.86		Moderately weathered grey, fine grained Quartzite								
2.50	77.61			2.25						33	23
3.00	76.86		Slightly weathered grey, fine grained Quartzite	3.00						43	Nil
3.50	76.36										
4.00	76.11		Fresh grey, fine grained Quartzite	3.75						83	46
4.50	75.36			4.50						85	26
5.00	74.86										
5.50	74.36										
6.00	73.86			6.00						53	33
6.50	73.36										
7.00	72.86		Slightly weathered grey, fine grained Quartzite								
7.50	72.36			7.50						73	25
8.00	71.86										
8.50	71.36										
9.00	70.86			9.00						59	7
9.50	70.36										
10.00	69.86										
10.50	69.36		Fresh black, fine grained Shale								
11.00	68.86										
11.50	69.36			10.5						71	7
12.00	67.86			12.00						55	15
12.50	67.36										
13.00	66.86										
13.50	66.36			13.50						67	26
14.00	65.86										
14.50	65.36										
15.00	64.86			15.00						72	57

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	37	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	78.670
LOCATION :	N = -302, E =68	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	1/13/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/17/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.67		Highly weathered grey, fine grained Quartzite								
0.50	77.92			0.75						27	Nil
1.00	77.67										
1.50	77.17			1.50						21	Nil
2.00	76.67		Slightly weathered grey, fine grained Quartzite								
2.50	76.42			2.25						45	37
3.00	75.92		Moderately weathered grey, fine grained Quartzite	2.75						36	16
3.50	75.17			3.50						37	37
4.00	74.67		Fresh grey, fine grained Quartzite								
4.50	74.17			4.50						83	19
5.00	73.67										
5.50	73.17			5.25						93	42
6.00	78.67										
6.50	72.17			6.50						65	19
7.00	71.67		Slightly weathered grey, fine grained Quartzite								
7.50	78.67										
8.00	70.67										
8.50	70.17			8.25						57	15
9.00	78.67										
9.50	69.17										
10.00	68.92			9.75						52	26
10.50	68.17		Fresh black, fine grained Shale								
11.00	67.67										
11.50	67.42			11.25						75	25
12.00	66.67										
12.50	66.17										
13.00	65.92			12.75						68	16
13.50	65.17										
14.00	64.67										
14.50	64.42			14.25						68	7
15.00	63.67									49	49

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	38	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	80.260
LOCATION :	N = -329 E = -3	**WATER TABLE below EGL (m) :**	6.00
		CASING Depth (m) :	1.50
START DATE :	2/23/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/25/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	80.26		Moderately Weathered grey, fine grained Fractured Quartzite								
0.50	79.76										
1.00	79.51			0.75						24	Nil
1.50	78.76			1.50						28	Nil
2.00	78.26		Slightly Weathered grey, fine grained Fractured Quartzite								
2.50	78.01			2.25						56	33
3.00	77.26			3.00						41	Nil
3.50	76.76										
4.00	76.51			3.75						39	Nil
4.50	75.76			4.50						49	Nil
5.00	75.26										
5.50	75.01			5.25						90	13
6.00	74.26			6.00						53	13
6.50	73.76										
7.00	73.51			6.75						47	13
7.50	72.76			7.50						39	Nil
8.00	72.26										
8.50	72.01			8.25						41	Nil
9.00	71.26			9.00						31	Nil
9.50	70.51			9.75						30	Nil
10.00	70.26			10.00						62	44

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	39	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	76.395
LOCATION :	N = -330, E =110	**WATER TABLE below EGL (m) :**	4.50
		CASING Depth (m) :	1.50
START DATE :	1/18/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/21/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	76.40		Slightly weathered grey, fine grained Quartzite								
0.50	75.65			0.75						44	44
1.00	75.40										
1.50	74.90			1.50						45	Nil
2.00	74.40										
2.50	74.15			2.25						55	25
3.00	73.40			3.00						43	Nil
3.50	72.90		Fresh grey, fine grained Quartzite								
4.00	72.65			3.75						67	24
4.50	71.90			4.50						69	16
5.00	71.40										
5.50	71.15			5.25						75	Nil
6.00	70.40			6.00						79	17
6.50	69.90										
7.00	69.65			6.75						79	57
7.50	68.90			7.50						55	34
8.00	68.40										
8.50	68.15			8.25						81	43
9.00	67.40		Fresh black, fine grained Shale	9.00						80	44
9.50	66.90										
10.00	66.65			9.75						62	62

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	40	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	76.093
LOCATION :	N = -357, E =-149	**WATER TABLE below EGL (m) :**	3.90
		CASING Depth (m) :	NA
START DATE :	3/17/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/18/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	76.09		Highly weathered grey, fine grained Quartzite	0.00							
0.50	75.59			0.75						26	Nil
1.00	75.09		Moderately weathered grey, fine grained Quartzite								
1.50	74.59			1.50						29	Nil
2.00	74.09		Slightly weathered grey, fine grained Quartzite	2.25						42	Nil
2.50	73.59										
3.00	73.09			3.00						54	34
3.50	72.59			3.75						49	18
4.00	72.09										
4.50	71.59			4.50						66	Nil
5.00	71.09										
5.50	70.59			5.25						46	26
6.00	70.09			6.00						42	Nil
6.50	69.59										
7.00	69.09			6.75						41	Nil
7.50	68.59			7.50						50	36
8.00	68.09										
8.50	67.59			8.25						57	26
9.00	67.09		Moderately weathered grey, fine grained Quartzite	9.00						26	14
9.50	66.59			9.75						28	Nil
10.00	66.09			10						36	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	41	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	78.812
LOCATION :	N = -356 E = -88	**WATER TABLE below EGL (m) :**	2.50
		CASING Depth (m) :	1.50
START DATE :	2/18/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/20/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.81										
0.50	78.31										
1.00	78.06			0.75						26	Nil
1.50	77.31		Moderately Weathered grey, fine grained Quartzite	1.50						25	Nil
2.00	76.81										
2.50	76.56			2.25						32	13
3.00	75.81			3.00						43	43
3.50	75.31										
4.00	75.06			3.75						84	73
4.50	74.31			4.50						92	55
5.00	73.81										
5.50	73.31										
6.00	72.81			6.00						72	34
6.50	72.31		Fresh grey, fine grained Quartzite								
7.00	71.81										
7.50	71.31			7.50						71	53
8.00	70.81										
8.50	70.31										
9.00	69.81			9.00						75	66
9.50	69.31										
10.00	68.81			10.00						65	65

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	42	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	78.327
LOCATION :	N = -360, E =45	**WATER TABLE below EGL (m) :**	3.60
		CASING Depth (m) :	NA
START DATE :	3/26/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/28/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
0.00	78.33			0.00							
0.50	77.83			0.75						44	Nil
1.00	77.33										
1.50	76.83		Slightly weathered grey, fine grained Quartzite	1.50						45	Nil
2.00	76.33			2.25						68	Nil
2.50	75.83										
3.00	75.33			3.00						45	26
3.50	74.83			3.75						44	29
4.00	74.33		Moderately weathered grey, fine grained Quartzite								
4.50	73.83			4.50						37	14
5.00	73.33										
5.50	72.83			5.25						52	17
6.00	72.33			6.00						46	Nil
6.50	71.83		Slightly weathered grey, fine grained Quartzite								
7.00	71.33			6.75						36	Nil
7.50	70.83			7.50						40	Nil
8.00	70.33										
8.50	69.83			8.25						56	Nil
9.00	69.33			9.00						37	Nil
9.50	68.83		Moderately weathered grey, fine grained Quartzite`								
10.00	68.33			10.00						25	Nil
10.50	67.83			10.50						58	32
11.00	67.33										
11.50	66.83			11.25						40	Nil
12.00	66.33			12.00						53	Nil
12.50	65.83		Slightly weathered black, fine grained Shale								
13.00	65.33			12.75						41	Nil
13.50	64.83			13.50						61	Nil
14.00	64.33										
14.50	63.83			14.25						53	Nil
15.00	63.33			15.00						40	14

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	43	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.005
LOCATION :	N = -369, E =-5	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	3/19/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/22/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.01			0.00							
0.50	81.51			0.75						26	Nil
1.00	81.01										
1.50	80.51		Moderately weathered grey, fine grained Quartzite	1.50						27	13
2.00	80.01			2.25						34	Nil
2.50	79.51										
3.00	79.01			3.00						38	Nil
3.50	78.51			3.75						38	Nil
4.00	78.01										
4.50	77.51			4.50						44	20
5.00	77.01										
5.50	76.51			5.25						42	Nil
6.00	76.01			6.00						52	Nil
6.50	75.51										
7.00	75.01		Slightly weathered grey, fine grained Quartzite	6.75						46	13
7.50	74.51			7.50						53	32
8.00	74.01										
8.50	73.51			8.25						45	Nil
9.00	73.01			9.00						38	30
9.50	72.26			9.75						54	54
10.00	72.01			10						56	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	44	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	83.598
LOCATION :	N=0 E=334	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/10/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/12/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth m	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)% %	Rock Quality Designation (RQD) %
0.00	83.60		Moderately Weathered grey, fine grained Limestone								
0.50	83.10										
1.00	82.85			0.75						24	Nil
1.50	82.10		Moderately Weathered grey, fine grained Limestone	1.50						36	Nil
2.00	81.60		Slightly Weathered grey, fine grained Quartzite								
2.50	81.35			2.25						42	42
3.00	80.60			3.00						48	48
3.50	80.10										
4.00	79.85			3.75						46	Nil
4.50	79.10			4.50						32	Nil
5.00	78.60										
5.50	78.35			5.25						42	33
6.00	77.60			6.00						45	26
6.50	76.85			6.75						56	Nil
7.00	76.60										
7.50	76.10			7.50						53	32
8.00	75.60		Fresh black, fine grained Shale								
8.50	75.35			8.25						90	Nil
9.00	74.60			9.00						84	Nil
9.50	74.10		Slightly Weathered black, fine grained Shale								
10.00	73.60			10.00						54	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	45	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	84.067
LOCATION :	N = 0, E = 408	**WATER TABLE below EGL (m) :**	4.90
		CASING Depth (m) :	0.50
START DATE :	3/8/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/9/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.07			0.00							
0.50	83.57			0.75						24	Nil
1.00	83.07										
1.50	82.57		Moderately weathered grey, fine grained Quartzite	1.50						34	16
2.00	82.07			2.25						45	29
2.50	81.57										
3.00	81.07			3.00						45	45
3.50	80.57			3.75						29	20
4.00	80.07										
4.50	79.57			4.50						42	26
5.00	79.07										
5.50	78.57			5.25						20	Nil
6.00	78.07			6.00						22	Nil
6.50	77.57										
7.00	77.07		Slightly weathered grey, fine grained Quartzite	6.75						36	36
7.50	76.57			7.50						36	13
8.00	76.07										
8.50	75.57			8.25						38	24
9.00	75.07			9.00						38	28
9.50	74.57			9.75						62	Nil
10.00	74.07			10.0						40	40

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	46	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	83.363
LOCATION :	N= 0, E= 454	**WATER TABLE below EGL (m) :**	3.10
		CASING Depth (m) :	1.50
START DATE :	4/25/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/26/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.36										
0.50	82.86										
1.00	82.61			0.75						21	Nil
1.50	81.86		Highly weathered grey, fine grained Limestone	1.50						25	Nil
2.00	81.36										
2.50	81.11			2.25						25	13
3.00	80.36			3.00						24	13
3.50	79.86										
4.00	79.61			3.75						24	Nil
4.50	78.86			4.50						24	Nil
5.00	78.36										
5.50	78.11			5.25						21	Nil
6.00	77.36		Moderately weathered grey, fine grained Limestone	6.00						22	Nil
6.50	76.86										
7.00	76.61			6.75						34	Nil
7.50	75.86			7.50						24	Nil
8.00	75.36										
8.50	74.86			8.25						33	Nil
9.00	74.36			9.00						38	Nil

BH NO. :	46	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	83.363
LOCATION :	N= 0, E= 454	**WATER TABLE below EGL (m) :**	3.10
		CASING Depth (m) :	1.50
START DATE :	4/25/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/26/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
9.50	73.86		Moderately weathered grey, fine grained Quartzite								
10.00	73.61			9.75						37	Nil
10.50	72.86			10.50						32	Nil
11.00	72.36										
11.50	71.86			11.25						37	13
12.00	71.36			12.00						28	Nil
12.50	70.86										
13.00	70.61			12.75						36	Nil
13.50	69.86			13.50						32	Nil
14.00	69.36										
14.50	68.86			14.25						54	30
15.00	68.36			15.00						50	Nil
15.50	67.86										
16.00	67.61			15.75						33	Nil
16.50	66.86			16.50						40	Nil
17.00	66.36										
17.50	65.86			17.25						50	16
18.00	65.36		Slightly weathered black, fine grained Shale	18.00						40	Nil
18.50	64.86										
19.00	64.61			18.75						37	13
19.50	63.86			19.50						54	Nil
20.00	63.36			20.00						44	24

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	47	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	84.008
LOCATION :	N= 0, E= 530	**WATER TABLE below EGL (m) :**	4.10
		CASING Depth (m) :	1.00
START DATE :	4/18/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/20/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.01										
0.50	83.51										
1.00	83.26		Highly weathered grey, fine grained Limestone	0.75						22	Nil
1.50	82.51			1.50						27	Nil
2.00	82.01										
2.50	81.76			2.25						23	Nil
3.00	81.01			3.00						30	Nil
3.50	80.51										
4.00	80.26		Moderately weathered grey, fine grained Limestone	3.75						30	Nil
4.50	79.51			4.50						32	Nil
5.00	79.01										
5.50	78.76			5.25						33	Nil
6.00	78.01			6.00						44	Nil
6.50	77.51		Slightly weathered grey, fine grained Limestone								
7.00	77.26			6.75						57	Nil
7.50	76.51			7.50						34	13
8.00	76.01		Moderately weathered grey, fine grained Limestone								
8.50	75.51			8.25						28	Nil
9.00	75.01			9.00						37	14
9.50	74.51		Moderately weathered grey, fine grained Quartzite	9.75						42	33
10.00	74.01			10.00						32	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	48	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	84.354
LOCATION :	N = 0, E = 627	**WATER TABLE below EGL (m) :**	3.70
		CASING Depth (m) :	NA
START DATE :	3/13/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/17/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.35		Moderately weathered grey, fine grained Quartzite	0.00							
0.50	83.85			0.75						21	Nil
1.00	83.35										
1.50	82.85			1.50						32	Nil
2.00	82.35			2.25						29	Nil
2.50	81.85										
3.00	81.35			3.00						34	14
3.50	80.85		Slightly weathered grey, fine grained Quartzite	3.75						53	17
4.00	80.35										
4.50	79.85			4.50						52	17
5.00	79.35		Moderately weathered black, fine grained Shale								
5.50	78.85			5.25						33	16
6.00	78.35			6.00						30	Nil
6.50	77.85										
7.00	77.35			6.75						40	Nil
7.50	76.85			7.50						48	17
8.00	76.35		Fresh black, fine grained Shale								
8.50	75.85			8.25						88	Nil
9.00	75.35			9.00						84	Nil
9.50	74.85										
10.00	74.35										
10.50	73.85			10.50						73	Nil
11.00	73.35		Slightly weathered black, fine grained Shale								
11.50	72.85										
12.00	72.35			12.00						54	10
12.50	71.85										
13.00	71.35										
13.50	70.85			13.50						58	20
14.00	70.35		Fresh grey, fine grained Quartzite								
14.50	69.85										
15.00	69.35			15.00						68	38

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	49	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	
LOCATION :	N = 0, E = 666	**WATER TABLE below EGL (m) :**	
		CASING Depth (m) :	
START DATE :	3/18/2016	**BORING/ DRILLING METHOD :**	
END DATE :	3/22/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%
				Depth	Type	15	30	45		
				m						%
0.00	84.90			0.00						
0.50	84.40		Highly weathered grey, fine grained Quartzite	0.75						21
1.00	83.90									
1.50	83.40			1.50						24
2.00	82.90			2.25						25
2.50	82.40									
3.00	81.90			3.00						28
3.50	81.40			3.75						29
4.00	80.90		Moderately weathered grey, fine grained Quartzite							
4.50	80.40			4.50						26
5.00	79.90									
5.50	79.40			5.25						26
6.00	78.90			6.00						25
6.50	78.40									
7.00	77.90			6.75						33
7.50	77.40			7.50						28
8.00	76.90		Moderately weathered grey, fine grained Limestone							
8.50	76.40			8.25						42
9.00	75.90			9.00						32
9.50	75.40									
10.00	74.90			9.75						32
10.50	74.40			10.50						33

BH NO. :	49	**EGL(EXISTING GROUND LEVEL) R.L.(+)**	84.900
LOCATION :	N = 0, E = 666	**WATER TABLE below EGL (m) :**	4.20
		CASING Depth (m) :	NA
START DATE :	3/18/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/22/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth m	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)% %	Rock Quality Designation (RQD) %
11.00	73.90										
11.50	73.40		Highly weathered black, fine grained Shale	11.25						24	Nil
12.00	72.90			12.00						24	Nil
12.50	72.40										
13.00	71.90			12.75						26	Nil
13.50	71.40		Moderately weathered black, fine grained Shale	13.50						30	30
14.00	70.90										
14.50	70.40			14.25						34	Nil
15.00	69.90			15.00						42	Nil
15.50	69.40		Slightly weathered black, fine grained Shale								
16.00	68.90			15.75						58	Nil
16.50	68.40		Fresh black, fine grained Shale	16.50						80	Nil
17.00	67.90										
17.50	67.40			17.25						86	13
18.00	66.90										
18.50	66.40		Fresh black, fine grained Quartzite								
19.00	65.90			18.75						72	18
19.50	65.40										
20.00	64.90			20.00						67	37

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	50	**EGL(EXISTING GROUND LEVEL)R.L.(+)(m)**	80.521
LOCATION :	N = -487, E =1295	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	12/15/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/19/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	80.52										
0.50	79.77		Highly weathered grey, fine grained Limestone	0.75						22	Nil
1.00	79.52										
1.50	79.02			1.50						33	15
2.00	78.52										
2.50	78.27			2.25						93	59
3.00	77.52			3.00						97	49
3.50	77.02										
4.00	76.52										
4.50	76.02			4.50						79	50
5.00	75.52										
5.50	75.02		Fresh pink grey, fine grained Limestone								
6.00	74.52			6.00						74	47
6.50	74.02										
7.00	73.52										
7.50	73.02			7.50						82	65
8.00	72.52										
8.50	72.02										
9.00	71.52			9.00						85	47
9.50	71.02		Fresh pink grey, fine grained Limestone								
10.00	70.77			9.75						83	28

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	51	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	82.157
LOCATION :	N= -69 E= 317	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	1/30/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/1/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth m	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD) %
0.00	82.16										
0.50	81.66										
1.00	81.41		Highly Weathered grey, fine grained Quartzite	0.75						21	Nil
1.50	80.66			1.50						21	Nil
2.00	80.16										
2.50	79.91			2.25						26	Nil
3.00	79.16			3.00						55	14
3.50	78.66		Slightly Weathered grey, fine grained Quartzite								
4.00	78.41			3.75						44	18
4.50	77.66			4.50						52	16
5.00	77.16										
5.50	76.91			5.25						26	Nil
6.00	76.16		Moderately Weathered grey, fine grained Quartzite	6.00						28	18
6.50	75.66										
7.00	75.41			6.75						33	33
7.50	74.66			7.50						33	Nil
8.00	74.16		Slightly Weathered grey, fine grained Quartzite								
8.50	73.91			8.25						50	Nil
9.00	73.16		Fresh grey, fine grained Limestone	9.00						92	Nil
9.50	72.41			9.75						90	Nil
10.00	72.16										
10.50	71.66			10.50						85	46
11.00	71.16										
11.50	70.16			12.00						75	Nil
12.00	70.16		Fresh black, fine grained Shale								
12.50	69.66										
13.00	69.16										
13.50	68.66			13.50						84	72
14.00	68.16										
14.50	67.66										
15.00	67.16			15.00						75	63

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	52	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	85.112
LOCATION :	N = -69 E = 454	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/2/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/4/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.11										
0.50	84.61										
1.00	84.36		Moderately Weathered grey, fine grained Quartzite	0.75						34	Nil
1.50	83.61			1.50						28	Nil
2.00	83.11										
2.50	82.86			2.25						27	Nil
3.00	82.11			3.00						49	39
3.50	81.61		Slightly Weathered grey, fine grained Quartzite								
4.00	81.36			3.75						45	Nil
4.50	80.61			4.50						57	Nil
5.00	80.11										
5.50	79.86			5.25						46	Nil
6.00	79.11			6.00						45	45
6.50	78.61		Slightly Weathered grey, fine grained Fractured Quartzite								
7.00	78.36			6.75						31	Nil
7.50	77.61			7.50						35	Nil
8.00	77.11										
8.50	76.86			8.25						39	28
9.00	76.11			9.00						78	23
9.50	75.36		Fresh grey, fine grained Quartzite	9.75						60	53
10.00	75.11			10.00						23	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	53	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	85.770
LOCATION :	N = -69, E = 604	**WATER TABLE below EGL (m) :**	5.80
		CASING Depth (m) :	0.50
START DATE :	3/25/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/27/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.77		Highly weathered grey, fine grained Quartzite	0.00							
0.50	85.27			0.75						22	Nil
1.00	84.77										
1.50	84.27			1.50						24	Nil
2.00	83.77			2.25						29	21
2.50	83.27		Moderately weathered grey, fine grained Quartzite								
3.00	82.77			3.00						29	13
3.50	82.27			3.75						28	18
4.00	81.77										
4.50	81.27			4.50						44	24
5.00	80.77		Highly weathered grey, fine grained Limestone								
5.50	80.27			5.25						29	Nil
6.00	79.77			6.00						22	Nil
6.50	79.27		Slightly weathered grey, fine grained Limestone								
7.00	78.77			6.75						54	Nil
7.50	78.27			7.50						52	13
8.00	77.77		Moderately weathered grey, fine grained Limetstone								
8.50	77.27			8.25						25	Nil
9.00	76.77			9.00						30	Nil
9.50	76.27		Slightly weathered grey, fine grained Limestone								
10.00	75.77			9.75						54	Nil
10.50	75.27			10.50						65	Nil
11.00	74.77		Slightly weatherd black, fine grained Shale								
11.50	74.27			11.25						44	Nil
12.00	73.77		Fresh black, fine grained Shale	12.00						64	Nil
12.50	73.27										
13.00	72.77			12.75						74	Nil
13.50	72.27			13.50						74	Nil
14.00	71.77										
14.50	71.27			14.25						73	Nil
15.00	70.77			15.00						80	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	54	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	80.120
LOCATION :	N = -69, E = 711	**WATER TABLE below EGL (m) :**	4.20
		CASING Depth (m) :	NA
START DATE :	3/26/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/27/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	80.12		Moderately weathered grey, fine grained Limestone	0.00							
0.50	79.62			0.75						28	Nil
1.00	79.12										
1.50	78.62			1.50						32	Nil
2.00	78.12			2.25						37	Nil
2.50	77.62		Highly weathered grey, fine grained Limestone								
3.00	77.12			3.00						22	Nil
3.50	76.62			3.75						24	Nil
4.00	76.12										
4.50	75.62			4.50						28	Nil
5.00	75.12		Highly weathered grey, fine grained Limestone								
5.50	74.62			5.25						22	Nil
6.00	74.12			6.00						25	Nil
6.50	73.62		Slightly weathered grey, fine grained Limestone								
7.00	73.12			6.75						48	Nil
7.50	72.62			7.50						53	Nil
8.00	72.12										
8.50	71.62			8.25						49	Nil
9.00	71.12			9.00						49	Nil
9.50	70.62			9.75						54	Nil
10.00	70.12		Fresh grey, fine grained Limestone	10.00						76	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	55	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	84.900
LOCATION :	N = -83 E = 284	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	1/22/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/28/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.90										
0.50	84.40										
1.00	84.15		Moderately Weathered grey, fine grained Quartzite	0.75						25	15
1.50	83.40			1.50						34	22
2.00	82.90										
2.50	82.65			2.25						29	Nil
3.00	81.90			3.00						21	Nil
3.50	81.40		Highly Weathered grey, fine grained Quartzite								
4.00	80.90			3.75						24	Nil
4.50	80.40			4.50						22	Nil
5.00	79.90										
5.50	79.40			5.25						63	51
6.00	78.90		Fresh grey, fine grained Quarzite	6.00						67	32
6.50	78.40										
7.00	77.90			6.75						86	17
7.50	77.40			7.50						97	32
8.00	76.90										
8.50	76.40		Fresh black, fine grained Shale								
9.00	75.90			9.00						89	Nil
9.50	75.40		Fresh black, fine grained Shale								
10.00	74.90			10.00						77	32

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	56	**EGL(EXISTING GROUND LEVEL)R.L.(+)(m)**	81.690
LOCATION :	N = -545, E =1231	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	12/11/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/14/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.69		Slightly weathered pink grey, fine grained Fractured Limestone								
0.50	80.94			0.75						53	Nil
1.00	80.69		Fresh pink grey, fine grained Limestone								
1.50	80.19			1.50						70	26
2.00	79.69										
2.50	79.44			2.25						81	33
3.00	78.69			3.00						95	56
3.50	78.19										
4.00	77.69										
4.50	77.19			4.50						77	34
5.00	76.69										
5.50	76.19										
6.00	75.69			6.00						65	9
6.50	75.19										
7.00	74.69										
7.50	74.19			7.50						80	Nil
8.00	73.69										
8.50	73.19										
9.00	72.69			9.00						79	Nil
9.50	72.19										
10.00	71.69										
10.50	71.19			10.50						81	21
11.00	70.69										
11.50	70.19										
12.00	69.69			12.00						83	Nil
12.50	69.19										
13.00	68.69										
13.50	68.19			13.50						91	Nil
14.00	67.69										
14.50	67.19										
15.00	66.69			15.00						88	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	57	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.333
LOCATION :	N = -99, E = 361	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	1/28/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/1/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.33		Moderately weathered grey, fine grained Limestone	0.00							
0.50	82.83			0.75						30	Nil
1.00	82.33										
1.50	81.83			1.50						34	Nil
2.00	81.33		Moderately weathered grey, fine grained Limestone	2.25						40	13
2.50	80.83		Moderately weathered grey, fine grained Quartzite								
3.00	80.33			3.00						33	16
3.50	79.83			3.75						41	Nil
4.00	79.33										
4.50	78.83			4.50						33	Nil
5.00	78.33		Fresh grey, fine grained Quartzite								
5.50	77.83			5.25						69	60
6.00	77.33			6.00						86	21
6.50	76.83		Moderately weathered grey, fine grained Quartzite								
7.00	76.33			6.75						32	Nil
7.50	75.83			7.50						26	Nil
8.00	75.33										
8.50	74.83			8.25						42	Nil
9.00	74.33			9.00						30	30

BH NO. :	57	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.333
LOCATION :	N = -99, E = 361	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	1/28/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/1/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
9.50	73.83										
10.00	73.33			9.75						94	29
10.50	72.83			10.50						85	29
11.00	72.33										
11.50	71.83										
12.00	71.33			12.00						72	Nil
12.50	70.83										
13.00	70.33										
13.50	69.83			13.50						64	28
14.00	69.33										
14.50	68.83		Fresh black, fine grained Shale								
15.00	68.33			15.00						76	59
15.50	67.83										
16.00	67.33										
16.50	66.83			16.50						72	54
17.00	66.33										
17.50	65.83										
18.00	65.33			18.00						72	67
18.50	64.83										
19.00	64.33										
19.50	63.83			19.50						73	24
20.00	63.33			20.00						62	28

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	58	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	84.475
LOCATION :	N = -99, E = 501	**WATER TABLE below EGL (m) :**	4.10
		CASING Depth (m) :	1.50
START DATE :	4/15/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/20/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.48		Highly weathered grey, fine grained Limestone	0.00							
0.50	83.73			0.75						21	Nil
1.00	84.48		Moderately weathered grey, fine grained Limestone								
1.50	82.98			1.50						41	Nil
2.00	82.23			2.25						38	Nil
2.50	84.48										
3.00	81.48			3.00						40	Nil
3.50	80.73			3.75						30	Nil
4.00	84.48										
4.50	79.98			4.50						34	Nil
5.00	84.48										
5.50	79.23			5.25						38	Nil
6.00	78.48			6.00						38	Nil
6.50	84.48		Slightly weathered grey, fine grained Limestone								
7.00	77.73			6.75						46	24
7.50	76.98			7.50						42	42
8.00	84.48										
8.50	76.23			8.25						46	22
9.00	75.48			9.00						38	Nil
9.50	84.48										
10.00	74.73			9.75						43	14

BH NO. :	58	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	84.475
LOCATION :	N = -99, E = 501	**WATER TABLE below EGL (m) :**	4.10
		CASING Depth (m) :	1.50
START DATE :	4/15/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/20/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
10.50	73.98		Slightly weathered grey, fine grained Limestone	10.50						43	Nil
11.00	84.48		Slightly weathered grey, fine grained Quartzite								
11.50	73.23			11.25						44	Nil
12.00	72.48		Highly weathered grey, fine grained Quartzite	12.00						21	Nil
12.50	84.48										
13.00	71.73			12.75						21	Nil
13.50	70.98		Slightly weathered grey, fine grained Quartzite	13.50						49	14
14.00	84.48										
14.50	70.23			14.25						54	Nil
15.00	69.48		Moderately weathered grey, fine grained Quartzite	15.00						34	Nil
15.50	84.48										
16.00	68.73			15.75						32	Nil
16.50	67.98			16.50						33	Nil
17.00	84.48		Slightly weathered grey, fine grained Quartzite								
17.50	67.23			17.25						42	Nil
18.00	66.48			18.00						46	16
18.50	84.48		Moderately weathered grey, fine grained Quartzite								
19.00	65.73			18.75						32	20
19.50	64.98			19.50						34	25
20.00	64.48			20.00						32	20

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	59	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	86.233
LOCATION :	N=-99, E= 569	**WATER TABLE below EGL (m) :**	3.90
		CASING Depth (m) :	1.50
START DATE :	4/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/13/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	86.23		Highly weathered grey, fine grained Limestone								
0.50	85.73										
1.00	85.48			0.75						22	Nil
1.50	84.73			1.50						25	Nil
2.00	84.23		Moderately weathered grey, fine grained Limestone								
2.50	83.98			2.25						40	Nil
3.00	83.23			3.00						42	Nil
3.50	82.73										
4.00	82.48			3.75						33	Nil
4.50	81.73		Moderately weathered grey, fine grained Quartzite	4.50						34	Nil
5.00	81.23										
5.50	80.98			5.25						33	Nil
6.00	80.23			6.00						32	Nil
6.50	79.73										
7.00	79.48			6.75						33	Nil
7.50	78.73			7.50						40	Nil
8.00	78.23										
8.50	77.73			8.25						40	40
9.00	77.23			9.00						38	30
9.50	76.73			9.75						42	42
10.00	76.23			10.00						32	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	60	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	82.160
LOCATION :	N = -99, E = 644	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	3/15/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/18/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.16		Highly weathered grey, fine grained Quartzite	0.00							
0.50	81.66			0.75						21	Nil
1.00	81.16										
1.50	80.66			1.50						16	Nil
2.00	80.16			2.25						10	Nil
2.50	79.66										
3.00	79.16			3.00						20	Nil
3.50	78.66			3.75						21	Nil
4.00	78.16										
4.50	77.66			4.50						20	Nil
5.00	77.16										
5.50	76.66			5.25						26	Nil
6.00	76.16			6.00						25	Nil
6.50	75.66										
7.00	75.16			6.75						24	Nil
7.50	74.66		Moderately weathered grey, fine grained Quartzite	7.50						30	Nil
8.00	74.16										
8.50	73.66			8.25						50	34
9.00	73.16			9.00						32	Nil

BH NO. :	60	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	82.160
LOCATION :	N = -99, E = 644	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	3/15/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/18/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
9.50	72.66		Slightly weathered grey, fine grained Quartzite								
10.00	72.16			9.75						50	33
10.50	71.66		Fresh grey, fine grained Quartzite	10.50						72	33
11.00	71.16										
11.50	70.66			11.25						63	13
12.00	70.16			12.00						69	Nil
12.50	69.66		Moderately weathered grey, fine grained Quartzite								
13.00	69.16			12.75						56	21
13.50	68.66			13.50						38	Nil
14.00	68.16										
14.50	67.66			14.25						22	Nil
15.00	67.16			15.00						34	Nil
15.50	66.66		Slightly weathered grey, fine grained Quartzite								
16.00	66.16			15.75						53	Nil
16.50	65.66			16.50						53	Nil
17.00	65.16										
17.50	64.66			17.25						40	Nil
18.00	64.16		Moderately weathered grey, fine grained Quartzite	18.00						32	Nil
18.50	63.66										
19.00	63.16			18.75						33	Nil
19.50	62.66			19.50						46	Nil
20.00	62.16			20.00						46	Nil

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	61	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	84.171
LOCATION :	N = -126 E = 406	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	2/2/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/6/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.17										
0.50	83.67		Highly weathered grey, fine grained Quartzite								
1.00	83.42			0.75						27	Nil
1.50	82.67			1.50						42	Nil
2.00	82.17		Slightly weathered grey, fine grained Quartzite								
2.50	81.92			2.25						49	31
3.00	81.17			3.00						67	33
3.50	80.67										
4.00	80.42		Fresh grey, fine grained Quartzite	3.75						68	Nil
4.50	79.67			4.50						53	13
5.00	79.17										
5.50	78.92			5.25						45	Nil
6.00	78.17			6.00						62	39
6.50	77.67		Fresh black, fine grained shale								
7.00	77.42			6.75						51	35
7.50	76.67			7.50						80	68
8.00	76.17										
8.50	75.92			8.25						44	33
9.00	75.17			9.00						48	44
9.50	74.67										
10.00	74.42			9.75						47	17
10.50	73.67			10.50						51	Nil
11.00	73.17		Fresh black, fine grained Shale								
11.50	72.92			11.25						81	49
12.00	72.17			12.00						83	70
12.50	71.67										
13.00	71.17										
13.50	70.67										
14.00	70.67			13.50						70	48
14.50	69.67										
15.00	69.17			15.00						61	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	62	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	86.090
LOCATION :	N=-126, E= 548	**WATER TABLE below EGL (m) :**	4.30
		CASING Depth (m) :	1.50
START DATE :	4/15/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/17/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	86.09		Highly weathered grey, fine grained Limestone								
0.50	85.59										
1.00	85.34			0.75						24	Nil
1.50	84.59		Slighlty grey, fine grained weathered Limestone	1.50						26	Nil
2.00	84.09										
2.50	83.84			2.25						44	Nil
3.00	83.09			3.00						53	Nil
3.50	82.59										
4.00	82.34			3.75						28	Nil
4.50	81.59			4.50						44	Nil
5.00	81.09										
5.50	80.84			5.25						41	Nil
6.00	80.09		Moderately weathered grey, fine grained Limestone	6.00						42	Nil
6.50	79.59		Fresh Quartzite and grey, fine grained Limestone								
7.00	79.34			6.75						82	Nil
7.50	78.59			7.50						86	44
8.00	78.09		Slightly weathered grey, fine grained Qaurtzite								
8.50	77.59										
9.00	77.09			9.00						48	24
9.50	76.59		Fresh black, fine grained Shale								
10.00	76.09										
10.50	75.59			10.50						70	24
11.00	75.09										
11.50	74.59										
12.00	74.09			12.00						69	43
12.50	73.59										
13.00	73.09										
13.50	72.59			13.50						63	14
14.00	72.09		Fresh black, fine grained Shale								
14.50	71.59										
15.00	71.09			15.00						89	14

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	63	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	81.578
LOCATION :	N = -126, E = 691	**WATER TABLE below EGL (m) :**	4.80
		CASING Depth (m) :	1.00
START DATE :	3/16/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/17/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.58		Moderately weathered grey, fine grained Limestone	0.00							
0.50	81.08			0.75						36	Nil
1.00	80.58										
1.50	80.08			1.50						42	Nil
2.00	79.58			2.25						17	Nil
2.50	79.08										
3.00	78.58			3.00						32	Nil
3.50	78.08			3.75						40	Nil
4.00	77.58		Slightly weathered grey, fine grained Limestone								
4.50	77.08			4.50						49	Nil
5.00	76.58										
5.50	76.08			5.25						57	24
6.00	75.58		Fresh grey, fine grained Quartzite	6.00						77	17
6.50	75.08										
7.00	74.58			6.75						61	32
7.50	74.08			7.50						62	Nil
8.00	73.58										
8.50	73.08			8.25						53	14
9.00	72.58			9.00						74	42
9.50	72.08		Slightly weathered grey, fine grained Quartzite								
10.00	71.58			9.75						52	Nil
10.50	71.08			10.50						42	22
11.00	70.58										
11.50	70.08			11.25						44	Nil
12.00	69.58		Fresh grey, fine grained Quartzite	12.00						68	36
12.50	69.08		Slightly weathered grey, fine grained Quartzite								
13.00	68.58			12.75						32	Nil
13.50	68.08			13.50						56	Nil
14.00	67.58										
14.50	67.08			14.25						41	34
15.00	66.58			15.00						40	20

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	64	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	83.770
LOCATION :	N = -157 E = 362	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	1/22/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/26/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.77										
0.50	83.27		Moderately Weathered grey, fine grained Limestone								
1.00	83.02			0.75						24	Nil
1.50	82.27			1.50						28	Nil
2.00	81.77										
2.50	81.52			2.25						35	Nil
3.00	80.77		Moderately Weathered grey, fine grained Quartzite	3.00						33	Nil
3.50	80.27										
4.00	80.02			3.75						25	17
4.50	79.27			4.50						44	Nil
5.00	78.77										
5.50	78.52			5.25						51	13
6.00	77.77			6.00						48	36
6.50	77.27		Slightly Weathered grey, fine grained Quartzite								
7.00	77.02			6.75						42	14
7.50	76.27			7.50						47	19
8.00	75.77										
8.50	75.52			8.25						49	Nil
9.00	74.77		Fresh black, fine grained Shale	9.00						82	Nil
9.50	74.02		Fresh black, fine grained Shale	9.75						95	19
10.00	73.77										

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	65	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	85.885
LOCATION :	N = -157 E = 502	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	2/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/14/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.89		Highly Weathered grey, fine grained Limestone								
0.50	85.39										
1.00	85.14			0.75						21	Nil
1.50	84.39		Moderately Weathered grey, fine grained Limestone	1.50						33	Nil
2.00	83.89										
2.50	83.64			2.25						30	13
3.00	82.89			3.00						36	Nil
3.50	82.39		Slightly Weathered grey, fine grained Limestone								
4.00	82.14			3.75						44	Nil
4.50	81.39			4.50						49	19
5.00	80.89		Fresh grey, fine grained Limestone								
5.50	80.64			5.25						86	35
6.00	79.89			6.00						83	45
6.50	79.39		Fresh grey, fine grained Limestone								
7.00	78.89										
7.50	78.39			7.50						74	28
8.00	77.89										
8.50	77.39										
9.00	76.89			9.00						80	62
9.50	76.39		Freshgrey, fine grained Limestone								
10.00	75.89										
10.50	75.39			10.50						77	21
11.00	74.89		Fresh grey, fine grained Quarzite								
11.50	74.39										
12.00	73.89			12.00						67	22
12.50	73.39		Fresh black, fine grained Shale								
13.00	72.89										
13.50	72.39			13.50						73	17
14.00	71.89		Slightly Weathered black, fine grained Shale								
14.50	71.39										
15.00	70.89			15.00						57	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	66	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	81.425
LOCATION :	N = -157, E = 645	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	NA
START DATE :	3/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/16/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.43			0.00							
0.50	80.93			0.75						49	16
1.00	80.43										
1.50	79.93			1.50						56	33
2.00	79.43			2.25						53	14
2.50	78.93										
3.00	78.43			3.00						48	Nil
3.50	77.93		Slightly weathered grey, fine grained Limestone	3.75						44	Nil
4.00	77.43										
4.50	76.93			4.50						53	Nil
5.00	76.43										
5.50	75.93			5.25						52	32
6.00	75.43			6.00						45	Nil
6.50	74.93										
7.00	74.43			6.75						53	13
7.50	73.93			7.50						53	Nil
8.00	73.43		Moderately weathered grey, fine grained Limestone								
8.50	72.93			8.25						37	Nil
9.00	72.43		Fresh grey, fine grained Limestone	9.00						85	30

BH NO. :	66	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	81.425
LOCATION :	N = -157, E = 645	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	NA
START DATE :	3/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/16/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
9.50	71.93		Fresh grey, fine grained limestone								
10.00	71.43			9.75						86	Nil
10.50	70.93										
11.00	70.43										
11.50	69.93			11.25						71	8
12.00	69.43		Fresh grey, fine grained Quartzite								
12.50	68.93										
13.00	68.43			12.75						75	22
13.50	67.93										
14.00	67.43										
14.50	66.93			14.25						64	26
15.00	66.43										
15.50	65.93										
16.00	65.43			15.75						83	16
16.50	64.93		Fresh black, fine grained Shale								
17.00	64.43										
17.50	63.93			17.25						78	8
18.00	63.43		Fresh black, fine grained Shale								
18.50	62.93										
19.00	62.43			18.75						68	42
19.50	61.93										
20.00	61.43			20.00						65	39

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	67	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.630
LOCATION :	N = -191, E =327	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	1/16/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/21/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.63										
0.50	82.13		Brownish Grey Fine to Medium Sandy silt			2					
1.00	81.63			1.00	SPT1	52	>50	>50	R		
1.50	81.13			1.50	SPT2	52	>50	>50	R		
2.00	80.63		Highly weathered grey, fine grained Quartzite								
2.50	80.38			2.25						20	Nil
3.00	79.63			3.00						40	Nil
3.50	79.13										
4.00	78.88			3.75						42	16
4.50	78.13			4.50						51	Nil
5.00	77.63										
5.50	77.38			5.25						45	29
6.00	76.63			6.00						48	15
6.50	76.13		Slightly weathered grey, fine grained Limestone								
7.00	75.88			6.75						36	36
7.50	75.13			7.50						32	32
8.00	74.63										
8.50	74.38			8.25						33	15
9.00	73.63			9.00						51	Nil
9.50	73.13										
10.00	72.88			9.75						56	Nil
10.50	72.13			10.50						60	33
11.00	71.63										
11.50	71.38			11.25						86	Nil
12.00	70.63			12.00						91	19
12.50	70.13										
13.00	69.63		Fresh black, fine grained Shale								
13.50	69.13			13.50						80	7
14.00	68.63										
14.50	68.13										
15.00	67.63			15.00						62	17

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	68	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.540
LOCATION :	N = -196, E =361	**WATER TABLE below EGL (m) :**	5.50
		CASING Depth (m) :	1.50
START DATE :	1/16/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/21/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.54		Highly weathered grey, fine grained Limestone								
0.50	82.04										
1.00	81.79			0.75						21	Nil
1.50	81.04		Moderately weathered grey, fine grained Limestone	1.50						31	Nil
2.00	80.54										
2.50	80.29			2.25						27	Nil
3.00	79.54			3.00						39	Nil
3.50	79.04										
4.00	78.79			3.75						36	Nil
4.50	78.04										
5.00	77.54										
5.50	77.29			5.25						33	Nil
6.00	76.54			6.00						28	21
6.50	76.04		Fresh grey, fine grained Limestone								
7.00	75.79			6.75						81	Nil
7.50	75.04			7.50						86	17
8.00	74.54										
8.50	74.04										
9.00	73.54			9.00						65	33
9.50	73.04										
10.00	72.54										

BH NO. :	68	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.540
LOCATION :	N = -196, E =361	**WATER TABLE below EGL (m) :**	5.50
		CASING Depth (m) :	1.50
START DATE :	1/16/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/21/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
10.50	72.04		Fresh black, fine grained Shale	10.50						79	15
11.00	71.54										
11.50	71.04										
12.00	70.54			12.00						67	17
12.50	70.04										
13.00	69.54										
13.50	69.04			13.50						75	24
14.00	68.54										
14.50	68.04										
15.00	67.54			15.00						66	47
15.50	67.04										
16.00	66.54										
16.50	66.04			16.50						72	33
17.00	65.54										
17.50	65.04										
18.00	64.54			18.00						78	28
18.50	64.04										
19.00	63.54										
19.50	63.04			19.50						83	75
20.00	62.54			20.00						40	40

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	69	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	83.155
LOCATION :	N = -191, E =395	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	1/14/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/16/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.16		Moderately weathered grey, fine grained Limestone								
0.50	82.66										
1.00	82.41			0.75						28	Nil
1.50	81.66		Moderately weathered grey, fine grained Limestone	1.50						35	Nil
2.00	81.16										
2.50	80.91			2.25						45	Nil
3.00	80.16			3.00						36	Nil
3.50	79.66										
4.00	79.41		Fresh grey, fine grained Limestone	3.75						81	31
4.50	78.66			4.50						95	21
5.00	78.16										
5.50	83.16										
6.00	77.16			6.00						66	14
6.50	76.66		Fresh grey, fine grained Limestone								
7.00	83.16										
7.50	75.66			7.50						63	Nil
8.00	75.16										
8.50	74.66										
9.00	74.16			9.00						68	53
9.50	73.66										
10.00	73.16										
10.50	72.66		Fresh black, fine grained Shale	10.50						60	20
11.00	72.16										
11.50	71.66										
12.00	71.16			12.00						38	Nil
12.50	70.66										
13.00	70.16										
13.50	69.66			13.50						69	22
14.00	69.16										
14.50	68.66										
15.00	68.16			15.00						73	16

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	70	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	85.365
LOCATION :	N = -191 E = 467	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	2/7/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/12/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.37		Moderately Weathered grey, fine grained Limestone								
0.50	84.87										
1.00	84.62			0.75						29	Nil
1.50	83.87		Slightly Weathered grey, fine grained Limestone	1.50						43	Nil
2.00	83.37										
2.50	83.12			2.25						47	Nil
3.00	82.37			3.00						39	Nil
3.50	81.87										
4.00	81.37			3.75						41	14
4.50	80.87		Fresh grey, fine grained Limestone	4.50						45	Nil
5.00	80.37										
5.50	79.87			5.25						87	28
6.00	79.37			6.00						88	29
6.50	78.87		Fresh grey, fine grained Quartzite								
7.00	78.37										
7.50	77.87			7.50						61	Nil
8.00	77.37										
8.50	76.87										
9.00	76.37			9.00						61	25
9.50	75.87										
10.00	75.37										
10.50	74.87			10.50						71	55
11.00	74.37										
11.50	73.87										
12.00	73.37			12.00						67	19
12.50	72.87										
13.00	72.37										
13.50	71.87			13.50						74	46
14.00	71.87										
14.50	70.87										
15.00	70.37			15.00						84	73

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	71	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	85.340
LOCATION :	N=-191 E= 536	**WATER TABLE below EGL (m) :**	4.20
		CASING Depth (m) :	1.50
START DATE :	4/18/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/22/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth m	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)% %	Rock Quality Designation (RQD) %
0.00	85.34		Highly weathered grey, fine grained Limestone								
0.50	84.84										
1.00	84.59			0.75						21	Nil
1.50	83.84		Moderately weathered grey, fine grained Limestone	1.50						24	Nil
2.00	83.34										
2.50	83.09			2.25						32	Nil
3.00	82.34			3.00						29	Nil
3.50	81.84										
4.00	81.59			3.75						41	Nil
4.50	80.84			4.50						29	Nil
5.00	80.34		Fresh grey, fine grained Limestone								
5.50	80.09			5.25						81	Nil
6.00	79.34			6.00						93	Nil
6.50	78.84		Slighlty weathered grey, fine grained Limestone								
7.00	78.34										
7.50	77.84			7.50						58	14
8.00	77.34		Fresh grey, fine grained Limestone								
8.50	76.84										
9.00	76.34			9.00						65	34
9.50	75.84										
10.00	75.34										
10.50	74.84			10.50						80	43
11.00	74.34		Fresh grey, fine grained Quartzite								
11.50	73.84										
12.00	73.34			12.00						67	24
12.50	72.84										
13.00	72.34										
13.50	71.84			13.50						73	7
14.00	71.34										
14.50	70.84										
15.00	70.34			15.00						78	50

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	72	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	85.731
LOCATION :	N= -191 E= 610	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/2/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/4/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.73		Slightly Weathered grey, fine grained Limestone								
0.50	85.23										
1.00	84.98			0.75						42	Nil
1.50	84.23			1.50						42	32
2.00	83.73										
2.50	83.48			2.25						40	35
3.00	82.73			3.00						49	Nil
3.50	82.23										
4.00	81.98			3.75						58	Nil
4.50	81.23		Fresh grey, fine grained Limestone	4.50						73	Nil
5.00	80.73										
5.50	80.48			5.25						90	72
6.00	79.73			6.00						85	14
6.50	79.23										
7.00	78.73										
7.50	78.23			7.50						75	57
8.00	77.73										
8.50	77.23										
9.00	76.73			9.00						76	19
9.50	76.23		Fresh grey, fine grained Limestone								
10.00	75.73										
10.50	75.23			10.50						73	15
11.00	74.73										
11.50	74.23										
12.00	73.73			12.00						75	71
12.50	73.23		Fresh grey, fine grained Quartzite								
13.00	72.73										
13.50	72.23			13.50						59	11
14.00	71.73										
14.50	71.23										
15.00	70.73			15.00						90	90

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	73	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	84.824
LOCATION :	N = -191, E =629	**WATER TABLE below EGL (m) :**	3.80
		CASING Depth (m) :	NA
START DATE :	3/13/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/14/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.82		Slightly weathered grey, fine grained Limestone	0.00							
0.50	84.32			0.75						45	17
1.00	83.82										
1.50	83.32			1.50						34	22
2.00	82.82			2.25						52	41
2.50	82.32		Fresh grey, fine grained Limestone								
3.00	81.82			3.00						70	70
3.50	81.32			3.75						81	68
4.00	80.82										
4.50	80.32			4.50						82	38
5.00	79.82										
5.50	79.32										
6.00	78.82			6.00						83	71
6.50	78.32		Slightly weathered grey, fine grained Limestone								
7.00	77.82										
7.50	77.32			7.50						76	73
8.00	76.82		Fresh grey, fine grained Limestone								
8.50	76.32										
9.00	75.82			9.00						80	65
9.50	75.32			9.50						76	76

THE BOREHOLE IS TERMINATED AT 9.50m BELOW G.L.

BH NO. :	74	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	85.487
LOCATION :	N = -205 E = 501	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/23/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/25/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.49										
0.50	84.99										
1.00	84.74		Highly weathered grey, fine grained Limestone	0.75						27	Nil
1.50	83.99			1.50						21	Nil
2.00	83.49										
2.50	83.24			2.25						35	Nil
3.00	82.49			3.00						60	17
3.50	81.99										
4.00	81.74			3.75						81	60
4.50	80.99			4.50						85	80
5.00	80.49		Fresh grey, fine grained Limestone								
5.50	79.99										
6.00	79.49			6.00						67	7
6.50	78.99										
7.00	78.49										
7.50	77.99			7.50						61	40
8.00	77.49										
8.50	76.99		Fresh grey, fine grained Limestone								
9.00	76.49			9.00						72	44
9.50	75.99										
10.00	75.49		Fresh grey, fine grained Limestone								
10.50	74.99			10.50						76	76

BH NO. :	74	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	85.487
LOCATION :	N = -205 E = 501	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/23/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/25/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
11.00	74.49		Moderately Weathered grey, fine grained Fractured Limestone								
11.50	73.99										
12.00	73.49			12.00						46	Nil
12.50	72.99		Fresh grey, fine grained Limestone								
13.00	72.49										
13.50	71.99			13.50						75	25
14.00	71.49		Fresh grey, fine grained Quartzite								
14.50	70.99										
15.00	70.49			15.00						77	59
15.50	69.99										
16.00	69.49										
16.50	68.99			16.50						77	57
17.00	68.49										
17.50	67.99										
18.00	67.49			18.00						79	45
18.50	66.99										
19.00	66.49										
19.50	65.99			19.50						67	44
20.00	65.49		Fresh black, fine grained Shale	20.00						86	50
THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.											

BH NO. :	75	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.479
LOCATION :	N= -205 E= 644	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/10/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/12/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.48		Moderately Weathered black, fine grained Shale								
0.50	81.98										
1.00	81.73			0.75						36	Nil
1.50	80.98			1.50						35	22
2.00	80.48		Fresh black, fine grained Shale								
2.50	80.23			2.25						64	52
3.00	79.48			3.00						75	54
3.50	78.98										
4.00	78.73			3.75						53	37
4.50	77.98			4.50						70	Nil
5.00	77.23			5.25						84	28
5.50	76.98										
6.00	76.48										
6.50	75.98										
7.00	75.73			6.75						90	40
7.50	74.98										
8.00	74.48										
8.50	74.23			8.25						90	51
9.00	73.48										
9.50	72.73			9.75						93	48
10.00	72.48			10.00						88	64

THE BOREHOLE IS TERMINATED AT 10.00 m BELOW G.L.

BH NO. :	76	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.160
LOCATION :	N = -229 E = 273	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	2/24/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/25/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.16		Moderately Weathered grey, fine grained Fractured Quartzite								
0.50	81.66										
1.00	81.41			0.75						25	Nil
1.50	80.66		Moderately Weathered grey, fine grained Quartzite	1.50						31	Nil
2.00	80.16										
2.50	79.91			2.25						37	37
3.00	79.16			3.00						32	Nil
3.50	78.66										
4.00	78.41			3.75						38	Nil
4.50	77.66			4.50						39	Nil
5.00	77.16		Fresh grey, fine grained Quartzite								
5.50	76.91			5.25						94	24
6.00	76.16			6.00						97	60
6.50	75.66		Slightly Weathered grey, fine grained Quartzite								
7.00	75.16										
7.50	74.66			7.50						43	13
8.00	74.16										
8.50	73.66										
9.00	73.16			9.00						43	25
9.50	72.66										
10.00	72.16			10.00						47	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	77	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.520
LOCATION :	N = -232, E =327	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	1/16/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/18/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
0.00	82.52										
0.50	82.02										
1.00	81.77			0.75						33	Nil
1.50	81.02		Moderately weathered grey, fine grained Limestone	1.50						29	Nil
2.00	80.52										
2.50	80.27			2.25						27	Nil
3.00	79.52			3.00						27	Nil
3.50	79.02										
4.00	78.77			3.75						41	31
4.50	78.02		Slightly weathered grey, fine grained Limestone	4.50						43	21
5.00	77.52										
5.50	77.27			5.25						39	19
6.00	76.52			6.00						83	Nil
6.50	76.02										
7.00	75.77			6.75						86	Nil
7.50	82.52										
8.00	74.52										
8.50	74.02			8.25						76	7
9.00	82.52										
9.50	73.02										
10.00	72.52			9.75						49	Nil
10.50	82.52		Fresh grey, fine grained Limestone								
11.00	71.52										
11.50	71.02			11.25						65	49
12.00	82.52										
12.50	70.02										
13.00	69.52			12.75						61	37
13.50	82.52										
14.00	68.52										
14.50	68.02			14.25						77	65
15.00	67.52			15.00						31	27

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	78	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	82.735
LOCATION :	N = -232, E =396	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	1/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/14/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.74										
0.50	82.24		Moderately weathered grey, fine grained Limestone								
1.00	81.99			0.75						33	Nil
1.50	81.24			1.50						46	Nil
2.00	80.74										
2.50	80.49			2.25						90	Nil
3.00	79.74			3.00						89	28
3.50	79.24										
4.00	78.74										
4.50	78.24			4.50						79	9
5.00	77.74										
5.50	77.24										
6.00	76.74		Fresh grey, fine grained Limestone	6.00						72	43
6.50	76.24										
7.00	75.74										
7.50	75.24			7.50						78	60
8.00	74.74										
8.50	74.24										
9.00	73.74			9.00						62	34
9.50	73.24										
10.00	72.74										
10.50	72.24			10.50						71	67
11.00	71.74										
11.50	71.24										
12.00	70.74			12.00						68	27
12.50	70.24										
13.00	69.74		Fresh black, fine grained Shale								
13.50	69.24			13.50						73	23
14.00	68.74										
14.50	68.24										
15.00	67.74			15.00						83	50

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	79	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	83.262
LOCATION :	N = -232, E =431	**WATER TABLE below EGL (m) :**	4.50
		CASING Depth (m) :	1.50
START DATE :	1/19/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/22/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.26										
0.50	82.76										
1.00	82.51		Moderately weathered grey, fine grained Limestone	0.75						25	Nil
1.50	81.76			1.50						32	Nil
2.00	81.26										
2.50	81.01			2.25						37	Nil
3.00	80.51			2.75						82	28
3.50	79.76			3.50						87	Nil
4.00	79.26										
4.50	78.76										
5.00	78.26										
5.50	78.01			5.25						69	21
6.00	77.26										
6.50	76.76		Fresh grey, fine grained Limestone								
7.00	76.51			6.75						67	25
7.50	75.76										
8.00	75.26										
8.50	75.01			8.25						80	33
9.00	74.26										
9.50	73.51			9.75						80	22
10.00	73.26			10.00						68	68

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	80	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	84.400
LOCATION :	N = -232, E =468	**WATER TABLE below EGL (m) :**	4.20
		CASING Depth (m) :	1.50
START DATE :	1/21/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/25/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.40		Moderately weathered grey, fine grained Limestone								
0.50	83.90										
1.00	83.65			0.75						34	Nil
1.50	82.90			1.50						51	Nil
2.00	82.40		Fresh grey, fine grained Limestone								
2.50	82.15			2.25						87	Nil
3.00	81.40			3.00						81	69
3.50	80.90										
4.00	80.40										
4.50	79.90			4.50						63	43
5.00	79.40										
5.50	78.90										
6.00	78.40			6.00						57	44
6.50	77.90		Fresh grey, fine grained Limestone								
7.00	77.40										
7.50	76.90			7.50						63	12
8.00	76.40										
8.50	75.90										
9.00	75.40			9.00						64	Nil
9.50	74.90										
10.00	74.40										
10.50	73.90			10.50						73	33
11.00	73.40		Fresh black, fine grained Shale								
11.50	72.90										
12.00	72.40			12.00						70	35
12.50	71.90										
13.00	71.40										
13.50	70.90			13.50						71	39
14.00	70.40										
14.50	69.90										
15.00	69.40			15.00						75	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	81	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	84.900
LOCATION :	N= -232 E= 536	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	2/25/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/28/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.90		Slightly Weathered black, fine grained Shale								
0.50	84.40										
1.00	84.15			0.75						49	49
1.50	83.40		Fresh black, fine grained Shale	1.50						76	22
2.00	82.90										
2.50	82.40			2.25						57	Nil
3.00	81.90			3.00						64	56
3.50	81.40										
4.00	80.90			3.75						92	Nil
4.50	80.40			4.50						86	20
5.00	79.90		Slightly Weathered black, fine grained Shale								
5.50	79.40										
6.00	78.90			6.00						56	34
6.50	78.40		Fresh black, fine grained Shale								
7.00	77.90										
7.50	77.40			7.50						61	29
8.00	76.90										
8.50	76.40										
9.00	75.90			9.00						69	19
9.50	75.40										
10.00	74.90										
10.50	74.40			10.50						72	29
11.00	73.90										
11.50	73.40										
12.00	72.90			12.00						61	46
12.50	72.40										
13.00	71.90										
13.50	71.40			13.50						68	51
14.00	70.90										
14.50	70.40										
15.00	69.90			15.00						80	73

THE BOREHOLE IS TERMINATED AT 15.00 m BELOW G.L.

BH NO. :	82	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	85.157
LOCATION :	N= -235 E=574	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	2/29/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/2/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.16										
0.50	84.66										
1.00	84.41		Moderately Weathered grey, fine grained Limestone	0.75						32	13
1.50	83.66			1.50						40	Nil
2.00	83.16										
2.50	82.91			2.25						34	Nil
3.00	82.16			3.00						40	13
3.50	81.41		Fresh grey, fine grained Limestone	3.75						97	16
4.00	81.16										
4.50	80.66			4.50						82	26
5.00	80.16										
5.50	79.66										
6.00	79.16			6.00						73	34
6.50	78.66										
7.00	78.16										
7.50	77.66			7.50						85	83
8.00	77.16										
8.50	76.66										
9.00	76.16			9.00						81	71
9.50	75.66		Fresh grey, fine grained Limestone								
10.00	75.16			10.00						86	74

THE BOREHOLE IS TERMINATED AT 10.00 m BELOW G.L.

BH NO. :	83	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	86.274
LOCATION :	N= -232 E= 611	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	2/28/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/29/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	86.27		Moderately Weathered grey, fine grained Limestone								
0.50	85.77										
1.00	85.52			0.75						30	Nil
1.50	84.77			1.50						32	13
2.00	84.27		Slightly Weathered grey, fine grained Limestone								
2.50	84.02			2.25						49	16
3.00	83.27			3.00						53	30
3.50	82.52			3.75						57	46
4.00	82.27										
4.50	81.77			4.50						50	29
5.00	81.27										
5.50	81.02			5.25						58	13
6.00	80.27			6.00						44	36
6.50	79.77										
7.00	79.52			6.75						37	Nil
7.50	78.77			7.50						44	20
8.00	78.27										
8.50	78.02			8.25						58	14
9.00	77.27		Fresh grey, fine grained Limestone	9.00						69	37
9.50	76.52			9.75						68	37
10.00	76.27			10.00						68	60

THE BOREHOLE IS TERMINATED AT 10.00 m BELOW G.L.

BH NO. :	84	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	86.254
LOCATION :	N= -232 E= 679	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	3/3/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/6/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	86.25		Highly Weathered black, fine grained Shale								
0.50	85.75										
1.00	85.50			0.75						24	Nil
1.50	84.75			1.50						24	Nil
2.00	84.25		Moderately Weathered black, fine grained Shale								
2.50	84.00			2.25						30	Nil
3.00	83.25			3.00						34	Nil
3.50	82.75										
4.00	82.50			3.75						30	Nil
4.50	81.75			4.50						34	Nil
5.00	81.25										
5.50	81.00			5.25						36	Nil
6.00	80.25			6.00						42	Nil
6.50	79.75		Fresh black, fine grained Shale								
7.00	79.50			6.75						80	Nil
7.50	78.75			7.50						86	81
8.00	78.25										
8.50	77.75										
9.00	77.25			9.00						68	26
9.50	76.75										
10.00	76.25										
10.50	75.75			10.50						74	51
11.00	75.25										
11.50	74.75										
12.00	74.25			12.00						60	32
12.50	73.75		Fresh grey, fine grained Quartzite								
13.00	73.25										
13.50	72.75			13.50						71	20
14.00	72.25										
14.50	71.75										
15.00	71.25			15.00						59	32

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	85	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	82.533
LOCATION :	N = -241, E =822	**WATER TABLE below EGL (m) :**	3.20
		CASING Depth (m) :	1.50
START DATE :	12/20/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/21/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
0.00	82.53		Slightly weathered grey pink, fine grained fractured Limestone								
0.50	82.03										
1.00	81.78			0.75						47	23
1.50	81.03		Fresh pink, fine grained Fractured Limestone	1.50						63	63
2.00	80.53										
2.50	80.28			2.25						83	49
3.00	79.53			3.00						97	67
3.50	79.03										
4.00	78.53										
4.50	78.03			4.50						76	28
5.00	77.53										
5.50	77.03										
6.00	76.53			6.00						80	57
6.50	76.03										
7.00	75.53										
7.50	75.03			7.50						76	43
8.00	74.53										
8.50	74.03										
9.00	73.53			9.00						80	48
9.50	73.03										
10.00	72.53			10.00						83	49

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	86	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	84.160
LOCATION :	N = -263, E =358	**WATER TABLE below EGL (m) :**	4.50
		CASING Depth (m) :	1.50
START DATE :	1/9/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/11/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.16		Highly weathered grey, fine grained Limestone								
0.50	83.66										
1.00	83.41			0.75						21	Nil
1.50	82.66		Slightly Weathered grey, fine grained Quartzite	1.50						46	Nil
2.00	82.16										
2.50	81.91			2.25						49	17
3.00	81.16			3.00						47	14
3.50	80.66										
4.00	80.41			3.75						35	Nil
4.50	79.66			4.50						51	28
5.00	79.16										
5.50	78.91			5.25						49	28
6.00	78.16			6.00						68	Nil
6.50	77.66										
7.00	77.41			6.75						39	Nil
7.50	76.66		Fresh grey, fine grained Quartzite	7.50						69	Nil
8.00	76.16										
8.50	75.91			8.25						84	77
9.00	75.16			9.00						90	79
9.50	74.66		Fresh red, fine grained Sandstone								
10.00	74.16										
10.50	73.66			10.50						64	10
11.00	73.16		Fresh black, fine grained Shale								
11.50	72.66										
12.00	72.16			12.00						69	15
12.50	71.66										
13.00	71.16										
13.50	70.66			13.50						74	15
14.00	70.16										
14.50	69.66										
15.00	69.16			15.00						75	9

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	87	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	85.222
LOCATION :	N=-263 E= 501	**WATER TABLE below EGL (m) :**	3.80
		CASING Depth (m) :	1.00
START DATE :	4/15/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/18/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.22		Moderately weathered grey, fine grained Limestone								
0.50	84.72										
1.00	84.47			0.75						36	Nil
1.50	83.72		Slightly weathered grey, fine grained Limestone	1.50						54	Nil
2.00	83.22										
2.50	82.97			2.25						53	Nil
3.00	82.22			3.00						58	28
3.50	81.72		Fresh grey, fine grained Limestone								
4.00	81.47			3.75						78	29
4.50	80.72			4.50						68	57
5.00	80.22										
5.50	79.97			5.25						65	46
6.00	79.22		Fresh grey, fine grained Limestone	6.00						73	62
6.50	78.72										
7.00	78.47			6.75						85	49
7.50	77.72		Fresh grey, fine grained Limestone	7.50						50	29
8.00	77.22										
8.50	76.72			8.25						81	81
9.00	76.22			9.00						81	81
9.50	75.72		Fresh grey, fine grained Limestone								
10.00	75.22										
10.50	74.72			10.50						51	14
11.00	74.22		Moderately weathered grey, fine grained Quartzite								
11.50	73.72										
12.00	73.22			12.00						32	Nil
12.50	72.72		Fresh grey, fine grained Quartzite								
13.00	72.22										
13.50	71.72			13.50						58	23
14.00	71.22										
14.50	70.72										
15.00	70.22			15.00						57	31

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	88	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	82.970
LOCATION :	N= -263 E= 642	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/1/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/3/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.97		Fresh grey, fine grained Limestone								
0.50	82.47										
1.00	82.22			0.75						63	36
1.50	81.47			1.50						58	50
2.00	80.97										
2.50	80.72			2.25						44	13
3.00	79.97			3.00						68	14
3.50	79.47										
4.00	79.22			3.75						53	29
4.50	78.47			4.50						34	40
5.00	77.97										
5.50	77.72			5.25						90	74
6.00	76.97			6.00						82	68
6.50	76.47										
7.00	75.97										
7.50	75.47			7.50						75	45
8.00	74.97										
8.50	74.47										
9.00	73.97			9.00						72	45
9.50	73.47		Fresh grey, fine grained Limestone								
10.00	72.97										
10.50	72.47			10.50						70	37
11.00	71.97										
11.50	71.47										
12.00	70.97			12.00						78	10
12.50	70.47		Slightly Weathered grey, fine grained Limestone								
13.00	69.97										
13.50	69.47			13.50						49	19
14.00	68.97		Fresh grey, fine grained Limestone								
14.50	68.47										
15.00	67.97			15.00						67	37

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	89	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	83.560
LOCATION :	N= -287 E= 290	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	2/27/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/29/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.56		Moderately Weathered black, fine grained Shale								
0.50	83.06										
1.00	82.81			0.75						30	Nil
1.50	82.06		Moderately Weathered black, fine grained Shale	1.50						30	Nil
2.00	81.56		Moderately Weathered grey, fine grained Quartzite								
2.50	81.31			2.25						40	16
3.00	80.56			3.00						34	20
3.50	80.06		Highly Weathered grey, fine grained Quartzite								
4.00	79.81			3.75						24	Nil
4.50	79.06			4.50						24	Nil
5.00	78.56										
5.50	78.31			5.25						22	16
6.00	77.56		Moderately Weathered grey, fine grained Quartzite	6.00						25	Nil
6.50	77.06										
7.00	76.81			6.75						40	Nil
7.50	76.06		Slightly Weathered grey, fine grained Quartzite	7.50						44	16
8.00	75.56										
8.50	75.31			8.25						26	13
9.00	74.56			9.00						54	Nil
9.50	73.81			9.75						56	29
10.00	73.56		Fresh grey, fine grained Quartzite	10.00						72	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	90	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	83.106
LOCATION :	N = -283, E =334	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	1/10/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/24/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.11										
0.50	82.61		Highly weathered grey, fine grained Limestone								
1.00	82.36			0.75						21	Nil
1.50	81.61			1.50						23	Nil
2.00	81.11										
2.50	80.86			2.25						71	17
3.00	80.11		Fresh grey, fine grained Limestone	3.00						51	Nil
3.50	79.61										
4.00	79.36			3.75						80	80
4.50	78.61			4.50						25	20
5.00	78.11		Moderately weathered grey, fine grained Limestone								
5.50	77.86			5.25						37	13
6.00	77.11			6.00						61	24
6.50	76.61										
7.00	76.36			6.75						29	Nil
7.50	75.61			7.50						51	Nil
8.00	75.11		Slightly weathered grey, fine grained Limestone								
8.50	74.86			8.25						40	Nil
9.00	74.11			9.00						49	17
9.50	73.61										
10.00	73.36			9.75						45	15
10.50	72.61			10.50						56	53
11.00	72.11										
11.50	71.86		Moderately weathered grey, fine grained Limestone	11.25						40	Nil
12.00	71.11			12.00						31	Nil
12.50	70.61										
13.00	70.36		Fresh grey, fine grained Limestone	12.75						85	56
13.50	69.61			13.50						59	13
14.00	69.11										
14.50	68.86		Fresh black, fine grained Shale	14.25						63	Nil
15.00	68.11			15.00						57	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	91	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	82.697
LOCATION :	N = -283, E =377	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	1/4/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/8/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.70		Moderately weathered grey, fine grained Limestone								
0.50	82.20										
1.00	81.95			0.75						29	Nil
1.50	81.20		Slightly weathered red, fine grained Sandstone	1.50						45	Nil
2.00	80.70										
2.50	80.45			2.25						34	Nil
3.00	79.70			3.00						42	19
3.50	79.20										
4.00	78.95			3.75						54	19
4.50	78.20		Moderately to Slightly weathered red, fine grained Conglomerate Sandstone	4.50						31	15
5.00	77.70										
5.50	77.45			5.25						51	16
6.00	76.70		Fresh grey, fine grained Quartzite	6.00						73	57
6.50	76.20										
7.00	75.95			6.75						65	15
7.50	75.20			7.50						42	Nil
8.00	74.70										
8.50	74.45			8.25						81	15
9.00	73.70			9.00						83	67
9.50	73.20										
10.00	72.70										
10.50	72.20			10.50						93	58

BH NO. :	91	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	82.697
LOCATION :	N = -283, E =377	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	1/4/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/8/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
11.00	71.70		Fresh black, fine grained Shale								
11.50	71.20										
12.00	70.70			12.00						84	16
12.50	70.20		Fresh black, fine grained Shale								
13.00	69.70										
13.50	69.20			13.50						85	30
14.00	68.70										
14.50	68.20										
15.00	67.70			15.00						86	46
15.50	67.20										
16.00	66.70										
16.50	66.20			16.50						77	25
17.00	65.70										
17.50	65.20										
18.00	64.70			18.00						84	47
18.50	64.20										
19.00	63.70										
19.50	63.20		Slightly weathered black, fine grained Shale	19.50						51	Nil
20.00	62.70			20.00						50	41

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	92	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	84.460
LOCATION :	N = -283 E = 477	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	1/25/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/28/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.46										
0.50	83.96		Moderately Weathered grey, fine grained Limestone								
1.00	83.71			0.75						30	Nil
1.50	82.96			1.50						32	Nil
2.00	82.46										
2.50	82.21		Moderately Weathered grey, fine grained Limestone	2.25						31	Nil
3.00	81.46			3.00						37	Nil
3.50	80.96										
4.00	80.71			3.75						81	Nil
4.50	79.96		Fresh grey, fine grained Limestone	4.50						83	16
5.00	79.46										
5.50	78.96										
6.00	78.46			6.00						76	52
6.50	77.96										
7.00	77.46		Fresh grey, fine grained Limestone								
7.50	76.96			7.50						74	43
8.00	76.46										
8.50	75.96		Slightly weathered grey, fine grained Limestone								
9.00	75.46			9.00						56	33
9.50	74.96										
10.00	74.46										
10.50	73.96			10.50						78	53
11.00	73.46										
11.50	72.96										
12.00	72.46		Fresh grey, fine grained Quartzite	12.00						86	37
12.50	71.96										
13.00	71.46										
13.50	70.96			13.50						76	50
14.00	70.46										
14.50	69.96										
15.00	69.46			15.00						65	9

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	93	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	85.095
LOCATION :	N=-283 E= 520	**WATER TABLE below EGL (m) :**	3.60
		CASING Depth (m) :	1.00
START DATE :	4/15/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/17/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.10		Highly weathered grey, fine grained Limestone								
0.50	84.60										
1.00	84.35			0.75						22	Nil
1.50	83.60			1.50						22	Nil
2.00	83.10		Fresh grey, fine grained Limestone								
2.50	82.85			2.25						88	37
3.00	82.10			3.00						81	73
3.50	81.60										
4.00	81.10										
4.50	80.60			4.50						77	61
5.00	80.10										
5.50	79.60										
6.00	79.10			6.00						91	77
6.50	78.60		Fresh grey, fine grained Limestone								
7.00	78.10										
7.50	77.60			7.50						88	75

THE BOREHOLE IS TERMINATED AT 7.50m BELOW G.L.

BH NO. :	94	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	85.390
LOCATION :	N = -283 E = 618	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/23/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/27/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.39		Moderately Weathered grey, fine grained Fractured Limestone								
0.50	84.89										
1.00	84.64			0.75						31	31
1.50	83.89		Slightly Weathered grey, fine grained Limestone	1.50						41	29
2.00	83.39										
2.50	83.14			2.25						51	35
3.00	82.39			3.00						61	Nil
3.50	81.89		Fresh grey, fine grained Limestone								
4.00	81.64			3.75						81	46
4.50	80.89			4.50						89	65
5.00	80.39										
5.50	79.89										
6.00	79.39			6.00						57	40
6.50	78.89										
7.00	78.39										
7.50	77.89			7.50						67	37
8.00	77.39		Fresh grey, fine grained Limestone								
8.50	76.89										
9.00	76.39			9.00						95	91
9.50	75.89		Fresh grey, fine grained Limestone								
10.00	75.39										
10.50	74.89			10.50						75	61
11.00	74.39		Slightly Weathered grey, fine grained Quartzite								
11.50	73.89										
12.00	73.39			12.00						54	20
12.50	72.89		Slightly Weathered grey, fine grained Quartzite								
13.00	72.39										
13.50	71.89										
14.00	71.89			13.50						43	Nil
14.50	70.89										
15.00	70.39			15.00						66	33

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	95	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	83.713
LOCATION :	N = -283, E =661	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/15/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.71		Moderately weathered grey, fine grained Limestone								
0.50	83.21										
1.00	82.96			0.75						31	Nil
1.50	82.21		Slightly weathered red, fine grained Sandstone	1.50						53	36
2.00	81.71										
2.50	81.46			2.25						43	36
3.00	80.71			3.00						43	13
3.50	80.21										
4.00	79.96			3.75						51	13
4.50	79.21		Fresh red, fine grained Conglomerate Sandstone	4.50						83	35
5.00	78.71										
5.50	78.46			5.25						87	51
6.00	83.71		Fresh grey, fine grained Quartzite								
6.50	77.21										
7.00	76.96			6.75						79	63
7.50	83.71										
8.00	75.71										
8.50	75.46			8.25						82	46
9.00	83.71										
9.50	74.21										
10.00	73.71			9.75						75	37
10.50	83.71										

BH NO. :	95	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	83.713
LOCATION :	N = -283, E =661	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/15/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
11.00	72.71		Fresh black, fine grained Shale	11.25						73	62
11.50	72.21										
12.00	83.71										
12.50	71.21		Fresh black, fine grained Shale	12.75						72	41
13.00	70.71										
13.50	83.71										
14.00	69.71			14.25						77	34
14.50	69.21										
15.00	83.71										
15.50	68.21			15.75						52	Nil
16.00	67.71										
16.50	83.71										
17.00	66.71			17.25						68	25
17.50	66.21										
18.00	83.71										
18.50	65.21			18.75						69	Nil
19.00	64.71										
19.50	83.71										
20.00	63.71			20.00						70	31

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	95	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	83.713
LOCATION :	N = -283, E =661	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/15/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	Penetration, cm 30	Penetration, cm 45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
11.00	72.71		Fresh black, fine grained Shale	11.25						73	62
11.50	72.21										
12.00	83.71										
12.50	71.21		Fresh black, fine grained Shale								
13.00	70.71			12.75						72	41
13.50	83.71										
14.00	69.71										
14.50	69.21			14.25						77	34
15.00	83.71										
15.50	68.21										
16.00	67.71			15.75						52	Nil
16.50	83.71										
17.00	66.71										
17.50	66.21			17.25						68	25
18.00	83.71										
18.50	65.21										
19.00	64.71			18.75						69	Nil
19.50	83.71										
20.00	63.71			20.00						70	31

THE BOREHOLE IS TERMINATED AT 20.00m BELOW G.L.

BH NO. :	96	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	83.987
LOCATION :	N = -302 E = 358	**WATER TABLE below EGL (m) :**	3.20
		CASING Depth (m) :	1.50
START DATE :	1/24/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/25/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth m	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
										%	%
0.00	83.99		Slightly Weathered grey, fine grained Limestone								
0.50	83.49										
1.00	83.24			0.75						42	Nil
1.50	82.49			1.50						45	21
2.00	81.99		Fresh Weathered grey, fine grained Limestone								
2.50	81.74			2.25						89	51
3.00	80.99		Fresh grey, fine grained fractured Limestone	3.00						89	Nil
3.50	80.49		Fresh grey, fine grained Limestone								
4.00	79.99										
4.50	79.49			4.50						60	Nil
5.00	78.99										
5.50	78.49										
6.00	77.99			6.00						70	24
6.50	77.49		Fresh grey, fine grained Quartzite								
7.00	76.99										
7.50	76.49			7.50						69	9
8.00	75.99										
8.50	75.49										
9.00	74.99			9.00						62	26
9.50	74.49										
10.00	73.99										
10.50	73.49			10.50						71	40
11.00	72.99										
11.50	72.49										
12.00	71.99			12.00						66	27
12.50	71.49										
13.00	70.99										
13.50	70.49										
14.00	70.49			13.50						70	Nil
14.50	69.49										
15.00	68.99			15.00						65	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	97	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	85.014
LOCATION :	N = -302 E = 501	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	1/29/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/31/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.01		Moderately Weathered grey, fine grained Limestone								
0.50	84.51										
1.00	84.26			0.75						32	Nil
1.50	83.51		Fresh grey, fine grained Limestone	1.50						60	Nil
2.00	83.01										
2.50	82.76			2.25						57	13
3.00	82.01			3.00						63	Nil
3.50	81.51										
4.00	81.26			3.75						83	47
4.50	80.51			4.50						89	61
5.00	80.01										
5.50	79.51										
6.00	79.01			6.00						71	Nil
6.50	78.51		Fresh grey, fine grained Limestone								
7.00	78.01										
7.50	77.51			7.50						63	Nil
8.00	77.01		Fresh grey, fine grained Limestone								
8.50	76.51										
9.00	76.01			9.00						75	46
9.50	75.51		Fresh greyish brown, fine grained Quartzite								
10.00	75.01										
10.50	74.51			10.50						66	40
11.00	74.01										
11.50	73.51										
12.00	73.01			12.00						78	37
12.50	72.51										
13.00	72.01										
13.50	71.51										
14.00	71.51			13.50						78	69
14.50	70.51										
15.00	70.01			15.00						83	83

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	98	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	83.842
LOCATION :	N = -302 E = 642	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	2/8/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/11/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.84		Moderately Weathered grey, fine grained Limestone								
0.50	83.34										
1.00	83.09			0.75						32	Nil
1.50	82.34			1.50						37	16
2.00	81.84		Fresh grey, fine grained Limestone								
2.50	81.59			2.25						51	Nil
3.00	80.84			3.00						32	Nil
3.50	80.34										
4.00	79.84			3.75						86	35
4.50	79.34			4.50						92	44
5.00	78.84										
5.50	78.34										
6.00	77.84			6.00						86	51
6.50	77.34		Fresh grey, fine grained Limestone								
7.00	76.84										
7.50	76.34			7.50						80	28
8.00	75.84										
8.50	75.34										
9.00	74.84			9.00						83	53
9.50	74.34		Fresh grey, fine grained Limestone								
10.00	73.84										
10.50	73.34			10.50						63	Nil
11.00	72.84		Fresh grey, fine grained Quartzite								
11.50	72.34										
12.00	71.84			12.00						66	18
12.50	71.34		Fresh black, fine grained Shale								
13.00	70.84										
13.50	70.34										
14.00	70.34			13.50						67	31
14.50	69.34		Fresh black, fine grained Shale								
15.00	68.84			15.00						71	40

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	99	**EGL(EXISTING GROUND LEVEL)R.L.(+) (m)**	83.842
LOCATION :	N = -330 E = 431	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	1/28/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/2/2016	**DRILLING :** NX SIZE double tube core barrel	

SCALE	RL	Graphic Log	Description	Sample		Penetration, cm				CR/N	RQD
			Approximate Surface Elevation: Existing Surface Elevation	Depth	Type	15	30	45	60		
				M						%	%
0.00	83.84		Moderately Weathered Pink Limestone								
0.50	83.84										
1.00	83.09			0.75						27	Nil
1.50	82.34		Slightly Weathered Pink Limestone	1.50						45	Nil
2.00	83.84										
2.50	81.59		Fresh Pinkish Limestone	2.25						91	Nil
3.00	80.84			3.00						87	Nil
3.50	83.84		Fresh Pinkish Limestone and Greyish Limestone								
4.00	83.84										
4.50	79.34			4.50						76	9
5.00	83.84		Fresh Greyish Limestone								
5.50	83.84										
6.00	77.84			6.00						88	67
6.50	83.84		Fresh Greyish Limestone and Greyish Quartzite								
7.00	83.84										
7.50	76.34			7.50						68	22
8.00	83.84		Fresh Greyish Quartzite								
8.50	83.84										
9.00	74.84			9.00						76	11
9.50	83.84										
10.00	73.84			10.00						70	30

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	100	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	84.416
LOCATION :	N = -330 E = 541	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/1/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/2/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.42		Moderatelygrey, fine grained Limestone								
0.50	83.92										
1.00	83.67			0.75						25	Nil
1.50	82.92			1.50						34	Nil
2.00	82.42										
2.50	82.17			2.25						35	Nil
3.00	81.42			3.00						50	Nil
3.50	80.92		Fresh grey, fine grained Limestone								
4.00	80.67			3.75						87	17
4.50	79.92			4.50						81	13
5.00	79.42		Fresh Pinkish, fine grained Limestone and Limestone								
5.50	78.92										
6.00	78.42			6.00						74	8
6.50	77.92		Fresh grey, fine grained Limestone								
7.00	77.42										
7.50	76.92			7.50						63	Nil
8.00	76.42		Fresh grey, fine grained Quartzite								
8.50	75.92										
9.00	75.42			9.00						69	40
9.50	74.92										
10.00	74.42			10.00						73	73

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	101	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	83.513
LOCATION :	N = -357 E = 341	**WATER TABLE below EGL (m) :**	3.80
		CASING Depth (m) :	1.50
START DATE :	1/23/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/27/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.51		Moderately Weathered Pink, fine grained Limestone								
0.50	83.01										
1.00	82.76			0.75						31	Nil
1.50	82.01			1.50						45	Nil
2.00	81.51		Fresh Pink, fine grained Limestone								
2.50	81.26			2.25						81	Nil
3.00	80.51			3.00						81	Nil
3.50	80.01		Slightly Weathered Greyish Pink, fine grained Limestone								
4.00	79.51										
4.50	79.01			4.50						48	Nil
5.00	78.51		Slightly Weathered Grey, fine grained Limestone								
5.50	78.01										
6.00	77.51			6.00						52	Nil
6.50	77.01		Moderately Weathered grey, fine grained Quartzite								
7.00	76.51										
7.50	76.01			7.50						27	Nil
8.00	75.51		Fresh grey, fine grained Quartzite								
8.50	75.01										
9.00	74.51			9.00						69	64
9.50	74.01										
10.00	73.51			10.00						69	59

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	102	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	84.299
LOCATION :	N = -357 E = 479	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	1/26/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/28/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.30		Moderately Weathered Pinkish Grey, fine grained Limestone								
0.50	83.80										
1.00	83.55			0.75						24	Nil
1.50	82.80			1.50						20	Nil
2.00	82.30		Fresh Pinkish Grey, fine grained Limestone								
2.50	82.05			2.25						84	13
3.00	81.30			3.00						92	55
3.50	80.80		Fresh Pinkish Grey, fine grained Limestone								
4.00	80.30										
4.50	79.80			4.50						72	20
5.00	79.30		Fresh grey, fine grained Limestone								
5.50	78.80										
6.00	78.30			6.00						75	13
6.50	77.80										
7.00	77.30										
7.50	76.80			7.50						78	8
8.00	76.30		Fresh grey, fine grained Limestone								
8.50	75.80										
9.00	75.30			9.00						77	Nil
9.50	74.80		Slightly Weathered grey, fine grained Quartzite								
10.00	74.30			10.00						50	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	103	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	84.499
LOCATION :	N = -357 E = 599	**WATER TABLE below EGL (m) :**	2.50
		CASING Depth (m) :	1.50
START DATE :	2/5/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/8/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth m	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD) %
0.00	84.50										
0.50	84.00										
1.00	83.75		Moderately Weathered Pinkish, fine grained Limestone	0.75						29	Nil
1.50	83.00			1.50						32	16
2.00	82.50										
2.50	82.25			2.25						31	Nil
3.00	81.50			3.00						32	32
3.50	81.00										
4.00	80.75			3.75						85	23
4.50	80.00		Fresh Pinkish, fine grained Limestone	4.50						89	53
5.00	79.50										
5.50	79.00										
6.00	78.50			6.00						70	43
6.50	78.00										
7.00	77.50		Fresh Pinkish Grey, fine grained Limestone								
7.50	77.00			7.50						67	28
8.00	76.50										
8.50	76.00		Fresh grey, fine grained Limestone								
9.00	75.50			9.00						70	68
9.50	75.00		Slightly Weathered grey, fine grained Limestone								
10.00	74.50			10.00						53	22

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	104	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	85.572
LOCATION :	N = -350, E =877	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	12/18/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/19/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.57		Slightly weathered pink, fine grained Limestone								
0.50	85.07										
1.00	84.82			0.75						56	19
1.50	84.07		Fresh pink, fine grained Limestone	1.50						61	53
2.00	83.57										
2.50	83.32			2.25						72	72
3.00	82.57			3.00						83	67
3.50	82.07										
4.00	81.57										
4.50	81.07			4.50						78	67
5.00	80.57										
5.50	80.07										
6.00	79.57			6.00						76	30
6.50	79.07										
7.00	78.57										
7.50	78.07			7.50						87	42
8.00	77.57										
8.50	77.07										
9.00	76.57			9.00						85	46
9.50	76.07										
10.00	75.57			10.00						64	64

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	105	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	85.005
LOCATION :	N = -363 E = 695	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	2/18/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/19/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.01		Highly Weathered Pinkish Grey, fine grained Limestone								
0.50	84.51										
1.00	84.26			0.75						20	Nil
1.50	83.51		Slightly Weathered Pinkish grey, fine grained Limestone	1.50						43	Nil
2.00	83.01										
2.50	82.76		Moderately Weathered Pinkish grey, fine grained Limestone	2.25						35	Nil
3.00	82.01			3.00						21	Nil
3.50	81.51										
4.00	81.26		Fresh Pinkish grey, fine grained Limestone	3.75						88	13
4.50	80.51			4.50						85	17
5.00	80.01										
5.50	79.51										
6.00	79.01			6.00						64	32
6.50	78.51		Fresh Pinkish grey, fine grained Limestone								
7.00	78.01										
7.50	77.51			7.50						72	Nil
8.00	77.01		Fresh grey, fine grained Limestone								
8.50	76.51										
9.00	76.01			9.00						68	8
9.50	75.51										
10.00	75.01			10.00						65	65

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	106	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	84.000
LOCATION :	N= -370 E= 423	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/2/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/3/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.00										
0.50	83.50										
1.00	83.25		Slightly Weathered black, fine grained Shale	0.75						44	Nil
1.50	82.50			1.50						42	Nil
2.00	82.00										
2.50	81.75			2.25						40	13
3.00	81.00			3.00						74	29
3.50	80.50										
4.00	80.25			3.75						77	30
4.50	79.50			4.50						62	17
5.00	79.00		Fresh black, fine grained Shale								
5.50	78.75			5.25						82	38
6.00	78.00			6.00						32	Nil
6.50	77.50										
7.00	77.25			6.75						88	28
7.50	76.50			7.50						96	26
8.00	76.00										
8.50	75.50		Fresh black, fine grained Shale								
9.00	75.00			9.00						77	30
9.50	74.50		Slightly Weathered grey, fine grained Quartzite								
10.00	74.00			10.00						49	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	107	**EGL(EXISTING GROUND LEVEL) R.L.(+) (m)**	84.375
LOCATION :	N = -370 E = 538	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	2/3/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/4/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.38										
0.50	83.88										
1.00	83.63		Moderately Weathered Pink, fine grained Limestone	0.75						33	Nil
1.50	82.88			1.50						35	Nil
2.00	82.38										
2.50	82.13			2.25						34	Nil
3.00	81.38			3.00						59	53
3.50	80.88		Slightly Weathered Pink, fine grained Limestone								
4.00	80.63			3.75						41	28
4.50	79.88			4.50						37	Nil
5.00	79.38										
5.50	79.13			5.25						70	51
6.00	78.38		Fresh Pink, fine grained Limestone	6.00						60	Nil
6.50	77.88										
7.00	77.63			6.75						86	32
7.50	76.88			7.50						81	17
8.00	76.38										
8.50	75.88		Fresh Pink, fine grained Limestone								
9.00	75.38			9.00						73	55
9.50	74.88		Fresh grey, fine grained Limestone								
10.00	74.38			10.00						55	12

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	108	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	85.345
LOCATION :	N = -375 E = 790	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	2/23/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/24/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.35		Moderately Weathered pink, fine grained Limestone								
0.50	84.85										
1.00	84.60			0.75						25	Nil
1.50	83.85			1.50						35	Nil
2.00	83.35		Slightly Weathered grey pink, fine grained Limestone								
2.50	83.10			2.25						43	17
3.00	82.35			3.00						49	Nil
3.50	81.85		Fresh grey pink, fine grained Limestone								
4.00	81.60			3.75						84	16
4.50	80.85			4.50						80	Nil
5.00	80.35										
5.50	79.85										
6.00	79.35			6.00						64	37
6.50	78.85										
7.00	78.35										
7.50	77.85			7.50						80	31
8.00	77.35										
8.50	76.85										
9.00	76.35			9.00						65	13
9.50	75.85										
10.00	75.35										
10.50	74.85			10.50						65	30
11.00	74.35		Fresh grey, fine grained Quartzite								
11.50	73.85										
12.00	73.35			12.00						63	63
12.50	72.85										
13.00	72.35										
13.50	71.85			13.50						57	55
14.00	71.35										
14.50	70.85										
15.00	70.35			15.00						71	71

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	109	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	88.560
LOCATION :	N = 908 E = 226	**WATER TABLE below EGL (m) :**	5.60
		CASING Depth (m) :	1.50
START DATE :	5/19/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	5/21/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	88.56		Moderately Weathered pink grey, fine grained Limestone								
0.50	88.06										
1.00	87.81			0.75						30	Nil
1.50	87.06		Slightly Weatheredpink grey, fine grained Limestone	1.50						37	Nil
2.00	86.56										
2.50	86.31			2.25						37	Nil
3.00	85.56		Fresh grey, fine grained Limestone	3.00						57	Nil
3.50	85.06		Moderately weathered grey, fine grained Limestone								
4.00	84.81			3.75						35	Nil
4.50	84.06			4.50						34	Nil
5.00	83.56										
5.50	83.06			5.25						34	Nil
6.00	82.56			6.00						28	Nil
6.50	82.06										
7.00	81.56			7.00						36	Nil
7.50	81.06		Moderately weathered grey, fine grained Quartzite	7.50						24	Nil
8.00	80.56										
8.50	80.06			8.25						39	Nil
9.00	79.56		Highly weathered grey, fine grained Quartzite	9.00						21	Nil
9.50	79.06			9.75						24	13
10.00	78.56			10.00						24	Nil
THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.											

BH NO. :	110	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	87.289
LOCATION :	N = 416 E = 485	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	5/7/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	5/10/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	87.29										
0.50	86.79										
1.00	86.54		Highly weathered grey, fine grained Quartzite	0.75						14	Nil
1.50	85.79			1.50						25	Nil
2.00	85.29										
2.50	85.04			2.25						21	Nil
3.00	84.29			3.00						26	Nil
3.50	83.79										
4.00	83.54			3.75						29	Nil
4.50	82.79		Moderately weathered grey, fine grained Quartzite	4.50						26	Nil
5.00	82.29										
5.50	81.79			5.25						24	Nil
6.00	81.29			6.00						25	Nil
6.50	80.79										
7.00	80.29			7.00						23	Nil
7.50	79.79		Highly weathered grey, fine grained Quartzite	7.50						21	Nil
8.00	79.29										
8.50	78.79			8.25						21	Nil
9.00	78.29			9.00						24	Nil
9.50	77.79			9.75						26	Nil
10.00	77.29										
10.50	76.79			10.50						28	Nil
11.00	76.29		Moderately weathered grey, fine grained Quartzite	11.25						28	Nil
11.50	75.79										
12.00	75.29			12.00						28	Nil
12.50	74.79			12.75						25	Nil
13.00	74.29										
13.50	73.79		Highly weathered grey, fine grained Quartzite	13.50						22	Nil
14.00	73.29			14.25						24	Nil
14.50	72.79		Moderately weathered grey, fine grained Quartzite								
15.00	72.29			15.00						34	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	111	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	84.192
LOCATION :	N=272 E= 472	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	4/22/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/24/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.19		Brownish Sand								
0.50	83.69										
1.00	83.44			0.75	SPT1	>50			R	Nil	Nil
1.50	82.69			1.50	SPT2	>50			R	Nil	Nil
2.00	82.19		Moderately weathered grey, fine grained Limestone								
2.50	81.94			2.25						26	Nil
3.00	81.19			3.00						21	Nil
3.50	80.69										
4.00	80.44			3.75						24	Nil
4.50	79.69			4.50						28	17
5.00	79.19										
5.50	78.94			5.25						28	Nil
6.00	78.19			6.00						28	Nil
6.50	77.69										
7.00	77.44			6.75						32	Nil
7.50	76.69			7.50						24	Nil
8.00	76.19		Moderately weathered grey, fine grained Quartzite								
8.50	75.69			8.25						24	13
9.00	75.19			9.00						37	13
9.50	74.69		Fresh grey, fine grained Quartzite								
10.00	74.19									80	80

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	112	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.383
LOCATION :	N=141 E= 644	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	4/29/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/30/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth m	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD) %
0.00	83.38		Highly weathered grey, fine grained Quartzite								
0.50	82.88										
1.00	82.63			0.75						21	Nil
1.50	81.88		Moderately weathered grey, fine grained Quartzite	1.50						36	Nil
2.00	81.38										
2.50	81.13			2.25						36	Nil
3.00	80.38			3.00						37	Nil
3.50	79.88										
4.00	79.63			3.75						34	Nil
4.50	78.88			4.50						26	17
5.00	78.38										
5.50	78.13			5.25						29	Nil
6.00	77.38		Highly weathered grey, fine grained Quartzite	6.00						21	Nil
6.50	76.88										
7.00	76.63			6.75						21	Nil
7.50	75.88			7.50						21	Nil
8.00	75.38										
8.50	74.88			8.25						22	Nil
9.00	74.38			9.00						17	Nil
9.50	73.88			9.75						17	Nil
10.00	73.38			10.00						21	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	113	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	82.601
LOCATION :	N= -129 E= -443	**WATER TABLE below EGL (m) :**	3.80
		CASING Depth (m) :	1.00
START DATE :	4/17/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/20/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.60										
0.50	82.10										
1.00	81.85			0.75						13	Nil
1.50	81.10		Grid	1.50						19	Nil
2.00	80.60										
2.50	80.35			2.25						21	Nil
3.00	79.60			3.00						21	Nil
3.50	79.10										
4.00	78.85		Highly weathered pink grey, fine grained Quartzite	3.75						22	Nil
4.50	78.10		Highly weathered pink grey, fine grained Limestone	4.50						23	Nil
5.00	77.60										
5.50	77.35		Highly weathered grey, fine grained Quartzite	5.25						21	Nil
6.00	76.60			6.00						23	Nil
6.50	76.10										
7.00	75.85			6.75						35	Nil
7.50	75.10			7.50						35	Nil
8.00	74.60		Moderately weathered grey, fine grained Quartzite								
8.50	74.10			8.25						28	Nil
9.00	73.60			9.00						40	Nil
9.50	73.10										
10.00	72.60			9.75						30	Nil
10.50	72.10			10.50						26	Nil
11.00	71.60										
11.50	71.10			11.25						28	Nil
12.00	70.60			12.00						21	Nil
12.50	70.10		Moderately weathered black, fine grained Shale								
13.00	69.60			12.75						26	Nil
13.50	69.10			13.50						28	Nil
14.00	68.60										
14.50	68.10			14.25						40	Nil
15.00	67.60			15.00						42	13

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	114	**EGL(EXISTING GROUND LEVEL)R.L.(+)(m)**	79.583
LOCATION :	N = -187, E = -294	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	1/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/14/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.58		Moderatetly weathered grey, fine grained Quartzite								
0.50	79.08										
1.00	78.83			0.75						26	Nil
1.50	78.08			1.50						27	Nil
2.00	77.58		Slightly weathered grey, fine grained Quartzite								
2.50	77.33			2.25						59	47
3.00	76.58			3.00						40	29
3.50	76.08		Moderately weathered grey, fine grained Quartzite								
4.00	75.83			3.75						33	15
4.50	75.08			4.50						32	Nil
5.00	74.58										
5.50	74.33			5.25						33	56
6.00	73.58			6.00						89	23
6.50	73.08		Fresh pink grey, fine grained Shale								
7.00	72.58										
7.50	72.08			7.50						70	48
8.00	71.58										
8.50	71.08										
9.00	70.58			9.00						76	33
9.50	70.08										
10.00	69.58			10.00						58	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	115	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	82.040
LOCATION :	N= -196 E= -461	**WATER TABLE below EGL (m) :**	3.80
		CASING Depth (m) :	1.50
START DATE :	4/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/14/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.04										
0.50	81.54		Grid								
1.00	81.29			0.75						21	Nil
1.50	80.54			1.50						24	Nil
2.00	80.04										
2.50	79.79			2.25						36	Nil
3.00	79.04		Moderately weathered grey, fine grained Quartzite	3.00						32	Nil
3.50	78.54										
4.00	78.29			3.75						44	13
4.50	77.54			4.50						40	17
5.00	77.04										
5.50	76.79			5.25					R	16	Nil
6.00	76.04		Completely weathered grey, fine grained Quartzite	6.00					R	8	Nil
6.50	75.54										
7.00	75.29			6.75					R	6	Nil
7.50	74.54			7.50					R	6	Nil
8.00	74.04										
8.50	73.54			8.25						41	Nil
9.00	73.04			9.00						41	Nil
9.50	72.54										
10.00	72.04			9.75						34	Nil
10.50	71.54			10.50						53	Nil
11.00	71.04										
11.50	70.54		Slightly weathered greyish pink, fine grained Limestone	11.25						50	Nil
12.00	70.04			12.00						49	Nil
12.50	69.54										
13.00	69.04			12.75						60	42
13.50	68.54			13.50						46	34
14.00	68.04										
14.50	67.54			14.25						65	38
15.00	67.04			15.00						62	28

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	116	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	82.650
LOCATION :	N= -214, E= -529	**WATER TABLE below EGL (m) :**	4.30
		CASING Depth (m) :	1.50
START DATE :	4/15/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/17/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.65										
0.50	82.15										
1.00	81.90		Grit	0.75	SPT1	>50			R	10	Nil
1.50	81.15			1.50	SPT2	>50			R	9	Nil
2.00	80.65										
2.50	80.40			2.25	SPT3	>50			R	16	Nil
3.00	79.65		Highly weathered grey, fine grained Quartzite	3.00						22	Nil
3.50	79.15										
4.00	78.90			3.75						29	16
4.50	78.15			4.50						28	17
5.00	77.65										
5.50	77.40			5.25						26	Nil
6.00	76.65		Moderately weathered grey, fine grained Quartzite	6.00						32	Nil
6.50	76.15										
7.00	75.90			6.75						26	Nil
7.50	75.15			7.50						32	17
8.00	74.65										
8.50	74.15			8.25						32	Nil
9.00	73.65			9.00						26	21
9.50	73.15		Fresh grey, fine grained Quartzite							44	18
10.00	72.65									32	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	117	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	81.215
LOCATION :	N = -246, E =-412	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	1/16/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/19/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.22										
0.50	80.72		Highly weathered grey, fine grained Quartzite								
1.00	80.47			0.75						23	Nil
1.50	79.72			1.50						24	20
2.00	79.22										
2.50	78.97		Moderately weathered grey, fine grained Quartzite	2.25						32	Nil
3.00	78.22			3.00						25	Nil
3.50	77.72										
4.00	77.47			3.75						45	45
4.50	76.72			4.50						69	69
5.00	76.22										
5.50	75.97		Slightly weathered grey, fine grained Quartzite	5.25						45	Nil
6.00	75.22			6.00						44	32
6.50	74.72										
7.00	74.47			6.75						37	Nil
7.50	73.72			7.50						51	51
8.00	73.22										
8.50	72.97		Moderately weathered grey, fine grained Quartzite	8.25						39	13
9.00	72.22			9.00						37	20
9.50	71.72		Fresh grey, fine grained Quartzite								
10.00	71.47			9.75						87	41
10.50	70.72			10.50						85	14
11.00	70.22										
11.50	69.72										
12.00	69.22			12.00						63	Nil
12.50	68.72										
13.00	68.22		Fresh grey, fine grained Shale								
13.50	67.72			13.50						71	39
14.00	67.22										
14.50	66.72										
15.00	66.22			15.00						65	15

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	118	**EGL(EXISTING GROUND LEVEL)R.L.(+)(m)**	78.400
LOCATION :	N = -269, E =-244	**WATER TABLE below EGL (m) :**	6.50
		CASING Depth (m) :	1.50
START DATE :	1/5/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/11/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.40		Highly weathered grey, fine grained Limestone								
0.50	77.90										
1.00	77.65			0.75						21	Nil
1.50	76.90		Moderately weathered grey, fine grained Limestone	1.50						45	27
2.00	76.40										
2.50	76.15			2.25						81	31
3.00	75.40			3.00						82	53
3.50	74.90										
4.00	78.40										
4.50	73.90			4.25						73	74
5.00	73.40										
5.50	78.40										
6.00	72.40			6.00						65	13
6.50	71.90		Fresh grey, fine grained Limestone								
7.00	78.40										
7.50	70.90			7.50						47	Nil
8.00	70.40										
8.50	69.90										
9.00	69.40			9.00						66	7
9.50	68.90										
10.00	68.40										
10.50	67.90		Fresh black, fine grained Shale	10.50						69	61
11.00	67.40										
11.50	66.90										
12.00	66.40			12.00						73	39
12.50	65.90										
13.00	65.40										
13.50	64.90			13.50						82	20
14.00	64.40										
14.50	63.90										
15.00	78.40										
15.50	62.90			15.00						88	42

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	119	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	80.580
LOCATION :	N = -359, E = -443	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	1.50
START DATE :	1/20/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	1/23/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	80.58		Highly weathered pink, fine grained Limestone								
0.50	80.08										
1.00	79.83			0.75						24	Nil
1.50	79.08		Moderately weathered pink, fine grained Limestone	1.50						23	Nil
2.00	78.58										
2.50	78.33			2.25						27	13
3.00	77.58			3.00						49	34
3.50	77.08										
4.00	76.83			3.75						84	64
4.50	76.08			4.50						87	52
5.00	75.58										
5.50	75.08										
6.00	74.58			6.00						61	44
6.50	74.08		Fresh grey, fine grained Limestone								
7.00	73.58										
7.50	73.08			7.50						64	Nil
8.00	72.58										
8.50	72.08										
9.00	71.58			9.00						61	Nil
9.50	71.08										
10.00	70.58										
10.50	70.08		Fresh black, fine grained Shale	10.50						64	16
11.00	69.58										
11.50	69.08										
12.00	68.58			12.00						71	21
12.50	68.08										
13.00	67.58										
13.50	67.08			13.50						72	23
14.00	66.58										
14.50	66.08										
15.00	65.58			15.00						66	17

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	120	**EGL(EXISTING GROUND LEVEL)R.L.(+)(m)**	79.250
LOCATION :	N = -328 E = -228	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/8/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/10/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.25		Moderately Weathered grey, fine grained Quartzite								
0.50	78.75										
1.00	78.50			0.75						31	Nil
1.50	77.75		Slightly Weathered grey, fine grained Quartzite	1.50						39	Nil
2.00	77.25										
2.50	77.00			2.25						49	17
3.00	76.25			3.00						59	21
3.50	75.75										
4.00	75.50			3.75						43	27
4.50	74.75			4.50						45	13
5.00	74.25										
5.50	74.00			5.25						58	27
6.00	73.25			6.00						45	37
6.50	72.75		Fresh grey, fine grained Fractured Quartzite								
7.00	72.50			6.75						75	Nil
7.50	71.75			7.50						44	24
8.00	71.25		Fresh pink grey, fine grained Limestone								
8.50	71.00			8.25						60	23
9.00	70.25		Fresh dark grey, fine grained Shale	9.00						54	Nil
9.50	69.75		Fresh dark grey, fine grained Shale								
10.00	69.50			9.75						71	Nil
10.50	68.75			10.50						69	15
11.00	68.25										
11.50	68.00			11.25						69	13
12.00	67.25			12.00						69	56
12.50	66.75		Slightly Weathered dark grey, fine grained Shale								
13.00	66.50			12.75						53	47
13.50	65.75										
14.00	65.75			13.50						57	38
14.50	65.00			14.25						49	32
15.00	64.25			15.00						55	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	121	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	79.756
LOCATION :	N = -426 E = -461	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	2/17/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/24/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.76										
0.50	79.26										
1.00	79.01		Highly Weathered grey, fine grained Fractured Quartzite	0.75						24	Nil
1.50	78.26			1.50						23	Nil
2.00	77.76										
2.50	77.51			2.25						29	Nil
3.00	76.76			3.00						44	39
3.50	76.26										
4.00	76.01			3.75						47	36
4.50	75.26			4.50						83	71
5.00	74.76										
5.50	74.51		Slightly Weathered grey, fine grained Quartzite	5.25						85	57
6.00	73.76										
6.50	73.26										
7.00	73.01			6.75						61	45
7.50	72.26										
8.00	71.76										
8.50	71.51			8.25						59	40
9.00	70.76										
9.50	70.26										
10.00	70.01		Slightly Weathered Dark Grey, fine grained Shale	9.75						59	15
10.50	69.26										
11.00	68.76										
11.50	68.51			11.25						47	13
12.00	67.76										
12.50	67.26										
13.00	67.01		Fresh Dark grey, fine grained Shale	12.75						70	14
13.50	66.26										
14.00	65.76										
14.50	65.51			14.25						77	58
15.00	64.76			15.00						87	71

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	122	**EGL(EXISTING GROUND LEVEL)R.L.(+)(m)**	79.784
LOCATION :	N = -355 E = -325	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/3/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/6/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.78		Moderately Weathered grey, fine grained Quartzite								
0.50	79.28										
1.00	79.03			0.75						31	Nil
1.50	78.28		Moderately Weathered grey, fine grained Quartzite	1.50						37	Nil
2.00	77.78										
2.50	77.53			2.25						22	Nil
3.00	76.78			3.00						32	Nil
3.50	76.28										
4.00	76.03			3.75						47	39
4.50	75.28			4.50						33	Nil
5.00	74.78		Slightly Weathered grey, fine grained Quartzite								
5.50	74.53			5.25						52	52
6.00	73.78			6.00						44	31
6.50	73.28										
7.00	73.03		Fresh grey, fine grained Quartzite	6.75						82	65
7.50	72.28			7.50						80	49
8.00	71.78										
8.50	71.28										
9.00	70.78			9.00						65	53
9.50	70.28										
10.00	69.78			10.00						82	82

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	123	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	79.563
LOCATION :	N= -444 E= -529	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	2/26/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/28/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.56		Slightly Weathered grey, fine grained Quartzite								
0.50	79.06										
1.00	78.81			0.75						41	Nil
1.50	78.06			1.50						45	Nil
2.00	77.56										
2.50	77.31			2.25						33	Nil
3.00	76.56			3.00						44	20
3.50	76.06										
4.00	75.81			3.75						52	Nil
4.50	75.06		Fresh grey, fine grained Quartzite	4.50						72	45
5.00	74.56										
5.50	74.31			5.25						70	Nil
6.00	73.56			6.00						50	33
6.50	73.06										
7.00	72.81			6.75						66	60
7.50	72.06			7.50						56	34
8.00	71.56										
8.50	71.31			8.25						64	40
9.00	70.56		Slightly Weathered grey, fine grained Quartzite	9.00						50	Nil
9.50	69.81			9.75						48	Nil
10.00	69.56			10.00						40	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	124	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	80.210
LOCATION :	N = -476, E = -412	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	2/11/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/15/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
0.00	80.21		Light Brown Grit and fine grained Quartzite								
0.50	79.71										
1.00	79.46			0.75						23	Nil
1.50	78.71		Moderately weathered grey, fine grained Quartzite	1.50						27	13
2.00	78.21										
2.50	77.96			2.25						27	Nil
3.00	77.21			3.00						22	Nil
3.50	76.71										
4.00	76.46			3.75						21	13
4.50	75.71			4.50						33	23
5.00	75.21		Slighltly Weathered grey, fine grained Quartzite								
5.50	74.96			5.25						50	Nil
6.00	74.21			6.00						71	Nil
6.50	73.71		Moderately weathered grey, fine grained Quartzite								
7.00	73.46			6.75						33	Nil
7.50	72.71			7.50						39	Nil
8.00	72.21		Fresh grey, fine grained Quartzite								
8.50	71.96			8.25						93	Nil
9.00	71.21			9.00						92	Nil
9.50	70.71		Fresh black, fine grained Shale								
10.00	70.21										
10.50	69.71			10.50						70	17
11.00	69.21		Fresh Dark Gray, fine grained Shale								
11.50	68.71										
12.00	68.21			12.00						75	47
12.50	67.71										
13.00	67.21										
13.50	66.71			13.50						76	31
14.00	66.21										
14.50	65.71										
15.00	65.21			15.00						67	30

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	125	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	81.818
LOCATION :	N= -527 E= -692	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/2/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/5/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.82		Slightly Weathered grey, fine grained Quartzite								
0.50	81.32										
1.00	81.07			0.75						50	40
1.50	80.32			1.50						48	38
2.00	79.82										
2.50	79.57			2.25						41	Nil
3.00	78.82			3.00						22	Nil
3.50	78.32										
4.00	78.07			3.75						49	Nil
4.50	77.32		Moderately Weathered grey, fine grained Quartzite	4.50						26	13
5.00	76.82										
5.50	76.57			5.25						70	33
6.00	75.82			6.00						38	30
6.50	75.32										
7.00	75.07		Slightly Weathered grey, fine grained Quartzite	6.75						45	33
7.50	74.32			7.50						36	Nil
8.00	73.82										
8.50	73.57			8.25						70	14
9.00	72.82			9.00						46	Nil
9.50	72.32										
10.00	72.07			9.75						46	16
10.50	71.32		Fresh grey, fine grained Quartzite	10.50						76	Nil
11.00	70.82										
11.50	70.57			11.25						85	28
12.00	69.82			12.00						74	Nil
12.50	69.32		Fresh pink, fine grained Limestone								
13.00	69.07			12.75						80	Nil
13.50	68.32			13.50						61	Nil
14.00	67.82		Fresh grey, fine grained Limestone								
14.50	67.57			14.25						66	13
15.00	66.82			15.00						53	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	126	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	76.260
LOCATION :	N= -586 E= -283	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/9/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/11/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	76.26		Moderately grey, fine grained Quartzite								
0.50	75.76										
1.00	75.26			0.75						34	Nil
1.50	74.76			1.50						21	Nil
2.00	74.26										
2.50	74.01			2.25						48	16
3.00	73.26			3.00						37	Nil
3.50	72.76										
4.00	72.51			3.75						38	Nil
4.50	71.76			4.50						24	Nil
5.00	71.26										
5.50	71.01			5.25						33	15
6.00	70.26			6.00						44	33
6.50	69.76										
7.00	69.51			6.75						34	Nil
7.50	68.76		Slightly Weathered grey, fine grained Quartzite	7.50						54	15
8.00	68.26										
8.50	68.01			8.25						49	Nil
9.00	67.26			9.00						61	Nil
9.50	66.51			9.75						54	Nil
10.00	66.26			10.00						52	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	127	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	76.640
LOCATION :	N= -615 E= -440	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/7/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/8/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	76.64		Moderately Weathered grey, fine grained Quartzite								
0.50	76.14										
1.00	75.89			0.75						24	Nil
1.50	75.14			1.50						32	Nil
2.00	74.64										
2.50	74.39			2.25						34	Nil
3.00	73.64			3.00						45	17
3.50	73.14										
4.00	72.89			3.75						34	Nil
4.50	72.14			4.50						38	Nil
5.00	71.64										
5.50	71.14			5.25						46	Nil
6.00	70.64			6.00						36	Nil
6.50	70.14			6.75						38	Nil
7.00	76.64										
7.50	69.14			7.50						36	Nil
8.00	68.64		Slightly Weathered grey, fine grained Quartzite								
8.50	68.39			8.25						52	28
9.00	67.64			9.00						48	Nil
9.50	66.89		Fresh grey, fine grained Quartzite	9.75						70	21
10.00	66.64			10.00						80	25

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	128	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	86.545
LOCATION :	N= -336, E= 1073	**WATER TABLE below EGL (m) :**	4.50
		CASING Depth (m) :	
START DATE :	15-04-2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	17-04-2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	86.55		Highly weathered pink, fine grained Limestone								
0.50	86.05										
1.00	85.55			0.75						24	Nil
1.50	85.05		Moderately weathered pink, fine grained Limestone	1.50						29	13
2.00	84.55										
2.50	84.05			2.25						25	18
3.00	83.55		Slightly weathered pink, fine grained Limestone	3.00						46	46
3.50	83.05										
4.00	82.55			3.75						33	30
4.50	82.05			4.50						52	48
5.00	81.55										
5.50	81.05			5.25						58	50
6.00	80.55		Fresh pink, fine grained Limestone	6.00						70	14
6.50	80.05										
7.00	79.55			6.75						88	88
7.50	79.05			7.50						98	54
8.00	78.55										
8.50	78.05										
9.00	77.55			9.00						87	71
9.50	77.05										
10.50	76.05			10.25						74	55
11.00	75.55		Fresh pink grey, fine grained Limestone								
11.50	75.05										
12.00	74.55			12.00						77	35
12.50	74.05		Fresh grey, fine grained Limestone								
13.00	73.55										
13.50	73.05			13.50						80	47
14.00	72.55		Fresh grey, fine grained Limestone								
14.50	72.05										
15.00	71.55			15.00						68	24

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	129	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	85.756
LOCATION :	N = -404 E = 1055	**WATER TABLE below EGL (m) :**	4.00
		CASING Depth (m) :	
START DATE :	26-01-2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	27-01-2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.76										
0.50	85.26										
1.00	84.76			0.75						81	69
1.50	84.26			1.50						87	81
2.00	83.76										
2.50	83.26										
3.00	82.76		Fresh Pink grey, fine grained Limestone	3.00						77	74
3.50	82.26										
4.00	81.76										
4.50	81.26			4.50						80	68
5.00	80.76										
5.50	80.26										
6.00	79.76			6.00						48	36

THE BOREHOLE IS TERMINATED AT 6.00m BELOW G.L.

BH NO. :	130	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	85.187
LOCATION :	N = -422, E=987	**WATER TABLE below EGL (m) :**	5.50
		CASING Depth (m) :	
START DATE :	14/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	15/12/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.19										
0.50	84.69										
1.00	84.19			0.75						85	29
1.50	83.69			1.50						95	48
2.00	83.19										
2.50	82.69										
3.00	82.19			3.00						78	47
3.50	81.69										
4.00	81.19										
4.50	80.69			4.50						93	43
5.00	80.19		Fresh pink grey, fine grained fractured limestone								
5.50	79.69										
6.00	79.19			6.00						82	35
6.50	78.69										
7.00	78.19										
7.50	77.69			7.50						83	30
8.00	77.19										
8.50	76.69										
9.00	76.19			9.00						87	58
9.50	75.69										
10.00	75.19			10.00						56	33

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	131	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	85.18
LOCATION :	N = -453, E = 1104	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	
START DATE :	20/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	21/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	85.18		Moderately weathered pink grey, fine grained Limestone								
0.50	84.68										
1.00	84.18			0.75						31	Nil
1.50	83.68			1.50						35	13
2.00	83.18		Fresh pink grey, fine grained Limestone								
2.50	82.68			2.25						95	80
3.00	82.18			3.00						87	44
3.50	81.68										
4.00	81.18										
4.50	80.68			4.50						80	60
5.00	80.18										
5.50	79.68										
6.00	79.18			6.00						76	73
6.50	78.68										
7.00	78.18										
7.50	77.68			7.50						87	44
8.00	77.18										
8.50	76.68										
9.00	76.18			9.00						90	82
9.50	75.68										
10.00	75.18			10.00						76	44

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	132	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	84.301
LOCATION :	N = -468 E = 778	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	1.50
START DATE :	2/20/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	2/22/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.30		Fresh pink grey, fine grained Limestone								
0.50	83.80										
1.00	83.55			0.75						91	76
1.50	82.80			1.50						89	45
2.00	82.30										
2.50	81.80										
3.00	81.30			3.00						78	33
3.50	80.80										
4.00	80.30										
4.50	79.80			4.50						70	28
5.00	79.30										
5.50	78.80										
6.00	78.30			6.00						70	30
6.50	77.80										
7.00	77.30										
7.50	76.80			7.50						71	52
8.00	76.30		Fresh pink grey, fine grained Limestone								
8.50	75.80										
9.00	75.30			9.00						64	41
9.50	74.80										
10.00	74.30										
10.50	73.80			10.50						88	59
11.00	73.30		Moderately Weathered grey, fine grained Quartzite								
11.50	72.80										
12.00	72.30			12.00						37	9
12.50	71.80		Fresh grey, fine grained Quartzite								
13.00	71.30										
13.50	70.80			13.50						59	31
14.00	70.30										
14.50	69.80										
15.00	69.30			15.00						81	38

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	133	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	78.501
LOCATION :	N = -510, E =-18	**WATER TABLE below EGL (m) :**	3.70
		CASING Depth (m) :	NA
START DATE :	3/25/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/26/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	78.50			0.00							
0.50	78.00			0.75						20	Nil
1.00	77.50		Highly weathered grey, fine grained Quartzite								
1.50	77.00			1.50						21	Nil
2.00	76.50			2.25						21	Nil
2.50	76.00										
3.00	75.50			3.00						21	Nil
3.50	75.00			3.75						28	Nil
4.00	74.50										
4.50	74.00		Moderately weathered grey, fine grained Quartzite	4.50						26	Nil
5.00	73.50										
5.50	73.00			5.25						34	14
6.00	72.50			6.00						36	Nil
6.50	72.00										
7.00	71.50			6.75						68	Nil
7.50	71.00			7.50						65	Nil
8.00	70.50		Fresh grey, fine grained Quartzite								
8.50	70.00			8.25						86	66
9.00	69.50			9.00						62	Nil
9.50	69.00			9.75						62	17
10.00	68.50			10.00						76	76

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	134	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	79.834
LOCATION :	N= -500 E= 312	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	3/4/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/5/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.83		Completely Weathered grey, fine grained Limestone								
0.50	79.33										
1.00	79.08			0.75		>50	>50	>50	R		
1.50	78.33			1.50		>50	>50	>50	R		
2.00	77.83		Fresh grey, fine grained Limestone								
2.50	77.58			2.25						66	14
3.00	76.83		Moderately Weathered grey, fine grained Limestone	3.00						38	Nil
3.50	76.33		Slightly Weathered grey, fine grained Quartzite								
4.00	76.08			3.75						48	29
4.50	75.33		Fresh grey, fine grained Quartzite	4.50						90	13
5.00	74.83										
5.50	74.33			5.25						76	14
6.00	73.83		Slightly Weathered grey, fine grained Quartzite	6.00						57	24
6.50	73.33										
7.00	73.08			6.75						58	17
7.50	72.33		Fresh pink grey, fine grained Limestone	7.50						74	62
8.00	71.83		Fresh black, fine grained Shale								
8.50	71.58			8.25						78	Nil
9.00	70.83			9.00						76	21
9.50	70.08			9.75						74	40
10.00	69.83			10.00						72	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	135	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	82.422
LOCATION :	N= -530 E= 428	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.00
START DATE :	3/7/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/8/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.42		Highly Weathered black, fine grained Shale								
0.50	81.92										
1.00	81.67			0.75						21	Nil
1.50	80.92		Moderately Weathered black, fine grained Shale	1.50						29	Nil
2.00	80.42										
2.50	80.17			2.25						34	Nil
3.00	79.42			3.00						36	Nil
3.50	78.92										
4.00	78.67			3.75						33	Nil
4.50	77.92			4.50						38	13
5.00	77.42		Slightly Weathered black, fine grained Shale								
5.50	76.92			5.25						45	Nil
6.00	76.42			6.00						50	20
6.50	75.92		Slightly Weathered grey, fine grained Quartzite								
7.00	75.67			6.75						52	16
7.50	74.92			7.50						48	Nil
8.00	74.42										
8.50	74.17			8.25						60	Nil
9.00	73.42			9.00						45	Nil
9.50	72.67			9.75						53	Nil
10.00	72.42		Fresh grey, fine grained Quartzite	10.00						64	64

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	136	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.328
LOCATION :	N= -532 E= 543	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/8/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/9/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.33										
0.50	82.83										
1.00	82.58			0.75						24	Nil
1.50	81.83		Moderately Weathered black, fine grained Shale	1.50						37	30
2.00	81.33										
2.50	81.08			2.25						30	Nil
3.00	80.33			3.00						21	Nil
3.50	79.83										
4.00	79.58			3.75						49	32
4.50	78.83		Slightly Weathered black, fine grained Shale	4.50						46	33
5.00	78.33										
5.50	78.08			5.25						42	22
6.00	77.33			6.00						86	44
6.50	76.83										
7.00	76.58			6.75						74	13
7.50	75.83		Fresh black, fine grained Shale	7.50						85	54
8.00	75.33										
8.50	75.08			8.25						60	50
9.00	74.33			9.00						61	29
9.50	73.58			9.75						61	30
10.00	73.33			10.00						60	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	137	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	81.893
LOCATION :	N= -574 E= 580	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/10/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/11/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.89		Moderately Weathered black, fine grained Shale								
0.50	81.39										
1.00	81.14			0.75						39	Nil
1.50	80.39		Slightly Weathered black, fine grained Shale	1.50						48	22
2.00	79.89										
2.50	79.64			2.25						62	57
3.00	78.89			3.00						45	20
3.50	78.39										
4.00	78.14			3.75						53	32
4.50	77.39			4.50						48	38
5.00	76.89										
5.50	76.64			5.25						52	51
6.00	75.89		Fresh black, fine grained Shale	6.00						64	41
6.50	75.39										
7.00	75.14			6.75						84	66
7.50	74.39			7.50						85	68
8.00	73.89										
8.50	73.39										
9.00	72.89			9.00						76	67
9.50	72.39										
10.00	71.89			10.00						59	50

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	138	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	76.065
LOCATION :	N = -596, E =19	**WATER TABLE below EGL (m) :**	4.10
		CASING Depth (m) :	NA
START DATE :	3/20/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/22/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	76.07			0.00							
0.50	75.57			0.75						24	Nil
1.00	75.07		Moderately weathered grey, fine grained Quartzite								
1.50	74.57			1.50						25	13
2.00	74.07			2.25						22	Nil
2.50	73.57										
3.00	73.07			3.00						25	Nil
3.50	72.57			3.75						48	16
4.00	72.07										
4.50	71.57			4.50						44	32
5.00	71.07										
5.50	70.57			5.25						49	13
6.00	70.07			6.00						25	Nil
6.50	69.57		Slightly weathered grey, fine grained Quartzite								
7.00	69.07			6.75						52	32
7.50	68.57			7.50						76	37
8.00	68.07										
8.50	67.57			8.25						58	26
9.00	67.07			9.00						53	Nil
9.50	66.57			9.75						53	Nil
10.00	66.07			10.00						60	40

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	139	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	73.623
LOCATION :	N = -675, E =-30	**WATER TABLE below EGL (m) :**	3.00
		CASING Depth (m) :	NA
START DATE :	3/19/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/20/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	73.62			0.00							
0.50	73.12			0.75						21	13
1.00	72.62										
1.50	72.12			1.50						21	14
2.00	71.62			2.25						28	Nil
2.50	71.12		Moderately weathered grey, fine grained Quartzite								
3.00	70.62			3.00						26	Nil
3.50	70.12			3.75						40	Nil
4.00	69.62										
4.50	69.12			4.50						33	Nil
5.00	68.62										
5.50	68.12			5.25						34	13
6.00	67.62			6.00						66	13
6.50	67.12		Fresh grey, fine grained Quartzite								
7.00	66.62			6.75						65	Nil
7.50	66.12			7.50						60	29
8.00	65.62										
8.50	65.12		Slightly weathered black, fine grained Shale	8.25						58	Nil
9.00	64.62			9.00						60	17
9.50	64.12		Moderately weathered black, fine grained Shale	9.75						38	Nil
10.00	63.62			10.00						40	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	140	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	73.329
LOCATION :	N = -673, E =57	**WATER TABLE below EGL (m) :**	3.80
		CASING Depth (m) :	NA
START DATE :	3/17/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/18/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	73.33		Highly weathered grey, fine grained Quartzite	0.00							
0.50	72.83			0.75						20	Nil
1.00	72.33										
1.50	71.83		Moderately weathered grey, fine grained Quartzite	1.50						32	16
2.00	71.33			2.25						37	17
2.50	70.83										
3.00	70.33			3.00						36	14
3.50	69.83		Slightly weathered grey, fine grained Quartzite	3.75						48	20
4.00	69.33										
4.50	68.83			4.50						46	29
5.00	68.33										
5.50	67.83			5.25						48	13
6.00	67.33			6.00						56	13
6.50	66.83		Fresh grey, fine grained Quartzite								
7.00	66.33			6.75						61	Nil
7.50	65.83		Slightly weathered grey, fine grained Quartzite	7.50						33	Nil
8.00	65.33										
8.50	64.83			8.25						49	49
9.00	64.33		Fresh grey, fine grained Quartzite	9.00						68	45
9.50	63.83		Moderately weathered grey, fine grained Quartzite	9.75						53	Nil
10.00	63.33			10.00						32	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	141	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	79.740
LOCATION :	N = -662, E =428	**WATER TABLE below EGL (m) :**	4.20
		CASING Depth (m) :	1.00
START DATE :	3/13/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/16/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
0.00	79.74		Highly weathered pink, fine grained Limestone	0.00							
0.50	79.24			0.75						36	Nil
1.00	78.74		Moderately weathered pink, fine grained Limestone								
1.50	78.24			1.50						54	28
2.00	77.74			2.25						52	33
2.50	77.24										
3.00	76.74			3.00						52	Nil
3.50	76.24		Slightly weathered pinkish grey, fine grained Limestone	3.75						49	37
4.00	75.74										
4.50	75.24			4.50						57	45
5.00	74.74										
5.50	74.24			5.25						42	13
6.00	73.74			6.00						72	28
6.50	73.24		Fresh pink, fine grained Limestone								
7.00	72.74			6.75						68	32
7.50	72.24		Slightly weathered grey, fine grained Quartzite	7.50						62	40
8.00	71.74										
8.50	71.24			8.25						37	Nil
9.00	70.74		Fresh grey, fine grained Quartzite	9.00						22	Nil
9.50	70.24		Moderately weathered grey, fine grained Quartzite	9.75						42	Nil
10.00	69.74			10.00						64	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	142	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	80.602
LOCATION :	N = -665, E =543	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	3/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/13/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	80.60		Highly weathered pink, fine grained Limestone	0.00							
0.50	80.10			0.75						24	Nil
1.00	79.60										
1.50	79.10			1.50						41	28
2.00	78.60			2.25						49	49
2.50	78.10										
3.00	77.60			3.00						38	17
3.50	77.10			3.75						49	38
4.00	76.60										
4.50	76.10			4.50						46	13
5.00	75.60		Moderately weathered pink, fine grained Limestone								
5.50	75.10			5.25						54	16
6.00	74.60			6.00						44	16
6.50	74.10										
7.00	73.60			6.75						50	Nil
7.50	73.10			7.50						54	Nil
8.00	72.60										
8.50	72.10			8.25						48	16
9.00	71.60			9.00						45	Nil
9.50	71.10			9.75						46	20
10.00	70.60		Fresh pink, fine grained Limestone	10.00						64	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	143	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.705
LOCATION :	N = -543, E = 888	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	
START DATE :	14/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	13/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.705		Slightly weathered pink grey, fine grained fractured limestone								
0.50	83.205										
1.00	82.705			0.75						47	17
1.50	82.205		Fresh pink grey, fine grained fractured limestone	1.50						80	17
2.00	81.705										
2.50	81.205			2.25						93	56
3.00	80.705										
3.50	80.205										
4.00	79.705			3.75						72	13
4.50	79.205										
5.00	78.705										
5.50	78.205			5.25						83	38
6.00	77.705										
6.50	77.205										
7.00	76.705			6.75						86	45
7.50	76.205										
8.00	75.705										
8.50	75.205			8.25						78	38
9.00	74.705										
9.50	74.205			9.75						84	68
10.00	73.705			10.00						78	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	144	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	84.23
LOCATION :	N = -564, E =1117	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	
START DATE :	8/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	10/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	84.23		Moderately Weathered grey red, fine grained limestone								
0.50	83.73										
1.00	83.48			0.75						37	Nil
1.50	82.73			1.25						47	Nil
2.00	84.23										
2.50	81.73		Fresh grey red, fine grained limestone	2.25						83	27
3.00	81.23			3.00						89	41
3.50	80.73										
4.00	84.23										
4.50	79.73			4.50						78	19
5.00	84.23										
5.50	78.73										
6.00	78.23			6.00						85	27
6.50	77.73										
7.00	84.23										
7.50	76.73			7.50						88	23
8.00	84.23										
8.50	75.73										
9.00	75.23			9.00						94	13
9.50	74.73										
10.00	74.23			10.00						87	29

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	145	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.402
LOCATION :	N = -611, E =870	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	
START DATE :	11/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	13/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.40		Slightly weathered pink, fine grained limestone								
0.50	82.90										
1.00	82.65			0.75						53	15
1.50	81.90		Fresh pink grey, fine grained limestone	1.50						82	69
2.00	83.40										
2.50	80.90			2.25						81	43
3.00	83.40										
3.50	79.90										
4.00	79.65			3.75						71	22
4.50	78.90										
5.00	83.40										
5.50	77.90			5.25						75	25
6.00	83.40										
6.50	76.90										
7.00	76.65			6.75						74	41
7.50	75.90										
8.00	83.40										
8.50	74.90			8.25						80	9
9.00	83.40										
9.50	73.90										
10.00	73.65			9.75						77	33
10.50	72.90										
11.00	83.40										
11.50	71.90			11.25						85	43
12.00	83.40										
12.50	70.90										
13.00	70.65			12.75						67	34
13.50	69.90										
14.00	83.40										
14.50	68.90			14.25						73	Nil
15.00	68.40			15.00						63	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	146	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	82.342
LOCATION :	N = -629, E = 802	**WATER TABLE below EGL (m) :**	Not stuck
		CASING Depth (m) :	
START DATE :	12/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	13/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample Depth	Sample Type	Penetration, cm 15	30	45	SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				m						%	%
0.00	82.34		Moderately wetahered pink grey, fine grained limestone								
0.50	81.84										
1.00	81.59			0.75						30	13
1.50	80.84		Fresh pink grey, fine grained limestone	1.50						83	46
2.00	82.34										
2.50	79.84			2.25						81	49
3.00	82.34										
3.50	78.84										
4.00	78.59			3.75						81	37
4.50	77.84		Fresh pink grey, fine grained fractured limestone								
5.00	82.34										
5.50	76.84			5.25						55	17
6.00	82.34										
6.50	75.84			6.75						74	34
7.00	82.34										
7.50	74.84										
8.00	82.34										
8.50	73.84			8.25						80	37
9.00	82.34										
9.50	72.84			9.75						89	55
10.00	72.34			10.00						96	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	147	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.822
LOCATION :	N = -631, E =1099	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	
START DATE :	7/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	9/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.82		Highly weathered pink, fine grained fractured limestone								
0.50	83.32										
1.00	83.07			0.75						23	Nil
1.50	82.32			1.50						96	79
2.00	83.82										
2.50	81.32			2.25						89	33
3.00	83.82										
3.50	80.32										
4.00	80.07			3.75						96	70
4.50	79.32										
5.00	83.82										
5.50	78.32			5.25						74	30
6.00	83.82										
6.50	77.32										
7.00	77.07			6.75						77	40
7.50	76.32										
8.00	83.82		Fresh pink grey, fine grained fine grained limestone								
8.50	75.32			8.25						40	15
9.00	83.82										
9.50	74.32										
10.00	74.07			9.75						61	20
10.50	73.32										
11.00	83.82										
11.50	72.32			11.25						66	26
12.00	83.82										
12.50	71.32										
13.00	71.07			12.75						71	53
13.50	70.32										
14.00	83.82										
14.50	69.32			14.25						72	38
15.00	68.82			15.00						70	59

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	148	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.164
LOCATION :	N = -660, E= 919	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	3.00
START DATE :	11/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	12/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.16										
0.50	82.66			0.50							
1.00	82.41			0.75						51	23
1.50	81.66			1.50						70	35
2.00	81.16										
2.50	80.91			2.25						85	50
3.00	80.16									97	43
3.50	79.66										
4.00	79.41			3.75							
4.50	78.66									80	42
5.00	78.16		Fresh pink grey, fine grained limestone								
5.50	77.91			5.25							
6.00	77.16									88	37
6.50	76.66										
7.00	76.41			6.75							
7.50	75.66									75	74
8.00	75.16										
8.50	74.91			8.25							
9.00	74.16									89	78
9.50	73.41			9.75							
10.00	73.16			10.00						81	81

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	149	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.58
LOCATION :	N = -649, E = 1031	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	
START DATE :	7/12/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	9/12/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.58		Highly weathered grey, fine grained Limestone								
0.50	83.08			0.50	DS1						
1.00	82.83			0.75						21	Nil
1.50	82.08		Fresh pink grey, fine grained Limestone	1.50						81	64
2.00	83.58										
2.50	81.08			2.25						93	79
3.00	83.58										
3.50	80.08										
4.00	79.83			3.75						73	39
4.50	79.08										
5.00	83.58										
5.50	78.08			5.25						68	41
6.00	83.58										
6.50	77.08										
7.00	76.83			6.75						81	37
7.50	76.08										
8.00	83.58										
8.50	75.08			8.25						75	33
9.00	83.58										
9.50	74.08			9.75						71	40
10.00	73.58			10.00						72	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	150	**EGL(EXISTING GROUND LEVEL)R.L.(+)(m)**	81.626
LOCATION :	N= -915, E= 1400	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.50
START DATE :	4/20/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/21/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.63		Moderately weathered pink, fine grained Limestone								
0.50	81.13										
1.00	80.63			0.75						28	Nil
1.50	80.13			1.50						38	Nil
2.00	79.63										
2.50	79.13			2.25						36	Nil
3.00	78.63			3.00						32	Nil
3.50	78.13		Slightly weathered pink, fine grained Limestone								
4.00	77.63			3.75						53	53
4.50	77.13			4.50						60	50
5.00	76.63										
5.50	76.13			5.25						50	50
6.00	75.63		Fresh pink, fine grained Limestone	6.00						73	73
6.50	75.13										
7.00	74.63			6.75						70	70
7.50	74.13			7.50						81	69
8.00	73.63										
8.50	73.13			8.25						88	88

THE BOREHOLE IS TERMINATED AT 8.25m BELOW G.L.

BH NO. :	151	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	83.5
LOCATION :	N = -681, E = 1148	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	
START DATE :	4/12/2015	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	6/12/2015	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	83.50		Highly weathered pink, fine grained Limestone								
0.50	83.00										
1.00	82.50			0.75						24	Nil
1.50	82.00		Fresh pink grey, fine grained Limestone	1.50						68	34
2.00	81.50										
2.50	81.00			2.25						90	Nil
3.00	80.50			3.00						86	77
3.50	80.00										
4.00	79.50										
4.50	79.00			4.50						100	21
5.00	78.50										
5.50	78.00										
6.00	77.50			6.00						74	31
6.50	77.00										
7.00	76.50										
7.50	76.00			7.50						22	Nil
8.00	75.50										
8.50	75.00										
9.00	74.50			9.00						73	41
9.50	74.00										
10.00	73.50			10.00						95	80

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	152	**EGL (EXISTING GROUND LEVEL)R.L.(+)(m)**	82.419
LOCATION :	N= -830 E= 1155	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.00
START DATE :	3/3/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/5/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	82.42		Highly Weathered black, fine grained Shale								
0.50	81.92										
1.00	81.67			0.75						20	Nil
1.50	80.92		Slightly Weathered black, fine grained Shale	1.50						44	Nil
2.00	80.42										
2.50	80.17			2.25						53	Nil
3.00	79.42			3.00						38	Nil
3.50	78.92		Fresh black, fine grained Shale								
4.00	78.67			3.75						84	Nil
4.50	77.92			4.50						81	81
5.00	77.42										
5.50	76.92										
6.00	76.42			6.00						87	40
6.50	75.92										
7.00	74.92			7.50						86	84
7.50	74.92										
8.00	74.42										
8.50	73.92										
9.00	73.42			9.00						75	64

THE BOREHOLE IS TERMINATED AT 9.00m BELOW G.L.

BH NO. :	153	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	87.057
LOCATION :	N = 74, E =997	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	NA
START DATE :	4/2/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/4/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	87.06		Highly weathered pink grey, fine grained Limestone	0.00							
0.50	86.31			0.75						26	Nil
1.00	87.06		Slightly weathered pink grey, fine grained Limestone								
1.50	85.56			1.50						44	Nil
2.00	84.81			2.25						46	Nil
2.50	87.06										
3.00	84.06			3.00						45	Nil
3.50	83.31			3.75						41	Nil
4.00	87.06										
4.50	82.56			4.50						60	Nil
5.00	87.06										
5.50	81.81			5.25						41	Nil
6.00	81.06			6.00						44	Nil
6.50	87.06		Moderately weathered pink , fine grained Limestone								
7.00	80.31			6.75						37	Nil
7.50	79.56			7.50						38	17
8.00	87.06		Slightly weathered grey, fine grained Quartzite								
8.50	78.81			8.25						41	34
9.00	78.06			9.00						44	13
9.50	77.31			9.75						41	Nil
10.00	77.06		Moderately weathered grey, fine grained Quartzite	10.00						36	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	154	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	90.195
LOCATION :	N= -113, E= 1200	**WATER TABLE below EGL (m) :**	3.80
		CASING Depth (m) :	1.00
START DATE :	4/10/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/12/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	90.20		Highly weathered grey, fine grained Limestone								
0.50	89.70										
1.00	89.20			0.75						24	Nil
1.50	88.70		Moderately weathered grey, fine grained Limestone	1.50						32	Nil
2.00	88.20										
2.50	87.95			2.25						28	Nil
3.00	87.20			3.00						34	Nil
3.50	86.70										
4.00	86.45			3.75						32	Nil
4.50	85.70			4.50						22	Nil
5.00	85.20										
5.50	84.95			5.25						40	Nil
6.00	84.20			6.00						46	Nil
6.50	83.70										
7.00	83.45			6.75						32	Nil
7.50	82.70			7.50						24	Nil
8.00	82.20										
8.50	81.95			8.25						41	Nil
9.00	81.20			9.00						44	Nil
9.50	80.45			9.75						42	Nil
10.00	80.20			10.00						36	Nil

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	155	**EGL (EXISTING GROUND LEVEL)R.L.(+)(m)**	81.867
LOCATION :	N= -911 E= 1164	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	NA
START DATE :	3/5/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/7/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.87		Moderately Weathered black, fine grained Shale								
0.50	81.37										
1.00	81.12			0.75						26	13
1.50	80.37			1.50						33	Nil
2.00	79.87		Slightly Weathered black, fine grained Shale								
2.50	79.62			2.25						45	22
3.00	78.87		Fresh black, fine grained Shale	3.00						61	53
3.50	78.37										
4.00	78.12			3.75						81	13
4.50	77.37			4.50						85	Nil
5.00	76.87										
5.50	76.37										
6.00	75.87			6.00						73	30
6.50	75.37										
7.00	74.87										
7.50	74.37			7.50						73	56
8.00	73.87										
8.50	73.37										
9.00	72.87			9.00						85	78
9.50	72.37										
10.00	71.87										
10.50	71.37			10.50						74	74
11.00	70.87			11.00						98	98

THE BOREHOLE IS TERMINATED AT 11.00m BELOW G.L.

BH NO. :	156	**EGL(EXISTING GROUND LEVEL)R.L.(+)(m)**	81.116
LOCATION :	N= -823, E= 1571	**WATER TABLE below EGL (m) :**	4.30
		CASING Depth (m) :	1.00
START DATE :	4/22/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/23/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	81.12		Highly weathered pink, fine grained Limestone								
0.50	80.62										
1.00	80.37			0.75						24	Nil
1.50	79.62		Moderately weathered pink, fine grained Limestone	1.50						37	16
2.00	79.12										
2.50	78.87			2.25						37	28
3.00	78.12		Slightly weathered pink, fine grained Limestone	3.00						44	18
3.50	77.62										
4.00	77.37			3.75						50	30
4.50	76.62			4.50						49	13
5.00	76.12		Fresh pink, fine grained Limestone								
5.50	75.87			5.25						64	64
6.00	75.12			6.00						58	58
6.50	74.62										
7.00	74.37			6.75						81	81
7.50	73.62			7.50						84	73
8.00	73.12										
8.50	72.62										
9.00	72.12			9.00						67	62
9.50	71.62			9.75						81	81

THE BOREHOLE IS TERMINATED AT 9.75m BELOW G.L.

BH NO. :	157	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	87.225
LOCATION :	N= -200, E= 1400	**WATER TABLE below EGL (m) :**	5.00
		CASING Depth (m) :	1.50
START DATE :	4/6/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/10/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	87.23										
0.50	86.73		Highly weathered pink , fine grained Limestone								
1.00	86.23			0.75						21	Nil
1.50	85.73			1.50						24	Nil
2.00	85.23		Moderately weathered grey, fine grained Quartzite								
2.50	84.73			2.25						30	Nil
3.00	84.23		Slightly weathered grey, fine grained Quartzite	3.00						52	Nil
3.50	83.73		Highly weathered grey, fine grained Quartzite								
4.00	83.23			3.75						21	Nil
4.50	82.73		Highly weathered grey, fine grained Limestone	4.50						22	Nil
5.00	82.23										
5.50	81.73			5.25						22	Nil
6.00	81.23		Moderately weathered pink grey, fine grained Limestone	6.00						30	Nil
6.50	80.73										
7.00	80.23			6.75						38	Nil
7.50	79.73		Slightly weathered grey, fine grained Limestone	7.50						38	Nil
8.00	79.23										
8.50	78.73			8.25						48	Nil
9.00	78.23			9.00						46	Nil
9.50	77.73			9.75						53	Nil
10.00	77.23										
10.50	76.73			10.50						46	Nil
11.00	76.23										
11.50	75.73		Slightly weathered grey, fine grained Quartzite	11.25						58	13
12.00	75.23			12.00						48	Nil
12.50	74.73										
13.00	74.23			12.75						73	Nil
13.50	73.73		Moderately weathered grey, fine grained Quartzite	13.50						29	Nil
14.00	73.23										
14.50	72.73			14.25						34	Nil
15.00	72.23			15.00						32	13

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	158	**EGL (EXISTING GROUND LEVEL)R.L.(+)(m)**	79.697
LOCATION :	N= -1178, E= 1122	**WATER TABLE below EGL (m) :**	3.20
		CASING Depth (m) :	1.00
START DATE :	4/20/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/22/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	79.70		Moderately weathered pink, fine grained Limestone								
0.50	79.20										
1.00	78.95			0.75						33	Nil
1.50	78.20		Fresh pink, fine grained Limestone	1.50						65	54
2.00	77.70										
2.50	77.45			2.25						49	38
3.00	76.70			3.00						68	60
3.50	76.20										
4.00	75.95			3.75						81	81
4.50	75.20			4.50						92	92
5.00	74.70										
5.50	74.20										
6.00	73.70			6.00						74	61
6.50	73.20										
7.00	72.70										
7.50	72.20			7.50						55	55

THE BOREHOLE IS TERMINATED AT 7.50m BELOW G.L.

BH NO. :	159	**EGL (EXISTING GROUND LEVEL)R.L.(+)(m)**	80.537
LOCATION :	N= -961, E= 890	**WATER TABLE below EGL (m) :**	3.50
		CASING Depth (m) :	1.00
START DATE :	4/20/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/22/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	80.54										
0.50	80.04										
1.00	79.79			0.75						61	61
1.50	79.04			1.50						78	68
2.00	78.54										
2.50	78.29			2.25						89	89
3.00	77.54		Fresh pink, fine grained Limestone	3.00						84	84
3.50	77.04										
4.00	80.54										
4.50	76.04			4.50						86	83
5.00	75.54										
5.50	75.04										
6.00	74.54			6.00						83	83

THE BOREHOLE IS TERMINATED AT 6.00m BELOW G.L.

BH NO. :	160	**EGL (EXISTING GROUND LEVEL)R.L.(+)(m)**	80.977
LOCATION :	N= -1040 E= 1021	**WATER TABLE below EGL (m) :**	Not struck
		CASING Depth (m) :	1.50
START DATE :	3/8/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	3/10/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	80.98		Moderately Weathered black, fine grained Shale								
0.50	80.48										
1.00	80.23			0.75						36	Nil
1.50	79.48			1.50						26	Nil
2.00	78.98		Slightly Weathered black, fine grained Shale								
2.50	78.73			2.25						42	13
3.00	77.98			3.00						52	Nil
3.50	77.48		Fresh black, fine grained Shale								
4.00	77.23			3.75						62	14
4.50	76.48			4.50						76	29
5.00	75.98										
5.50	75.73			5.25						94	94
6.00	74.98			6.00						93	93
6.50	74.48										
7.00	73.98										
7.50	73.48			7.50						91	91
8.00	72.98										
8.50	72.48										
9.00	71.98			9.00						77	77
9.50	71.48										
10.00	70.98			10.00						91	91

THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	161	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	89.075
LOCATION :	N= -434, E= 1627	**WATER TABLE below EGL (m) :**	3.80
		CASING Depth (m) :	1.50
START DATE :	4/11/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/14/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	89.08		Completely weathered grey, fine grained Quartzite								
0.50	88.58										
1.00	88.08			0.75		>50	>50	>50	R	4	Nil
1.50	87.58		Highly weathered grey, fine grained Quartzite	1.50						21	Nil
2.00	87.08										
2.50	86.58			2.25						21	Nil
3.00	86.08			3.00						21	Nil
3.50	85.58		Moderately weathered grey, fine grained Quartzite								
4.00	85.08			3.75						32	Nil
4.50	84.58			4.50						24	Nil
5.00	84.08										
5.50	83.58			5.25						22	Nil
6.00	83.08			6.00						22	Nil
6.50	82.58										
7.00	82.08			6.75						26	Nil
7.50	81.58			7.50						28	Nil
8.00	81.08										
8.50	80.58			8.25						40	Nil
9.00	80.08			9.00						37	28
9.50	79.58			9.75						41	Nil
10.00	79.08										
10.50	78.58			10.50						32	16
11.00	78.08		Slightly weathered grey, fine grained Quartzite								
11.50	77.58			11.25						42	32
12.00	77.08			12.00						48	16
12.50	76.58										
13.00	76.08			12.75						40	18
13.50	75.58			13.50						36	13
14.00	75.08										
14.50	74.58			14.25						56	56
15.00	74.08			15.00						64	Nil

THE BOREHOLE IS TERMINATED AT 15.00m BELOW G.L.

BH NO. :	162	**EGL(EXISTING GROUND LEVEL) R.L.(+)(m)**	87.298
LOCATION :	N = -314, E =1182	**WATER TABLE below EGL (m) :**	4.10
		CASING Depth (m) :	1.00
START DATE :	4/1/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/2/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	87.30		Completely weathered pink , fine grained Limestone	0.00							
0.50	86.80			0.75	SPT1	>52	>50	>50	R	4	Nil
1.00	86.30										
1.50	85.80			1.50	SPT2	>52	>50	>50	R	2	Nil
2.00	85.30			2.25	SPT3	>52	>50	>50	R	Nil	Nil
2.50	84.80										
3.00	84.30			3.00	SPT4	>52	>50	>50	R	4	Nil
3.50	83.80			3.75	SPT5	>52	>50	>50	R	Nil	Nil
4.00	83.30										
4.50	82.80			4.50	SPT6	>52	>50	>50	R	2	Nil
5.00	82.30										
5.50	81.80			5.25	SPT7	>52	>50	>50	R	Nil	Nil
6.00	81.30			6.00	SPT8	>52	>50	>50	R	Nil	Nil
6.50	80.80										
7.00	80.30			6.75	SPT9	>52	>50	>50	R	Nil	Nil
7.50	79.80		Moderately weathered pink , fine grained Limestone	7.50						37	Nil
8.00	79.30										
8.50	78.80			8.25						37	Nil
9.00	78.30		Fresh grey, fine grained Limestone	9.00						68	13
9.50	77.80			9.75						64	Nil
10.00	77.30			10.00						92	Nil

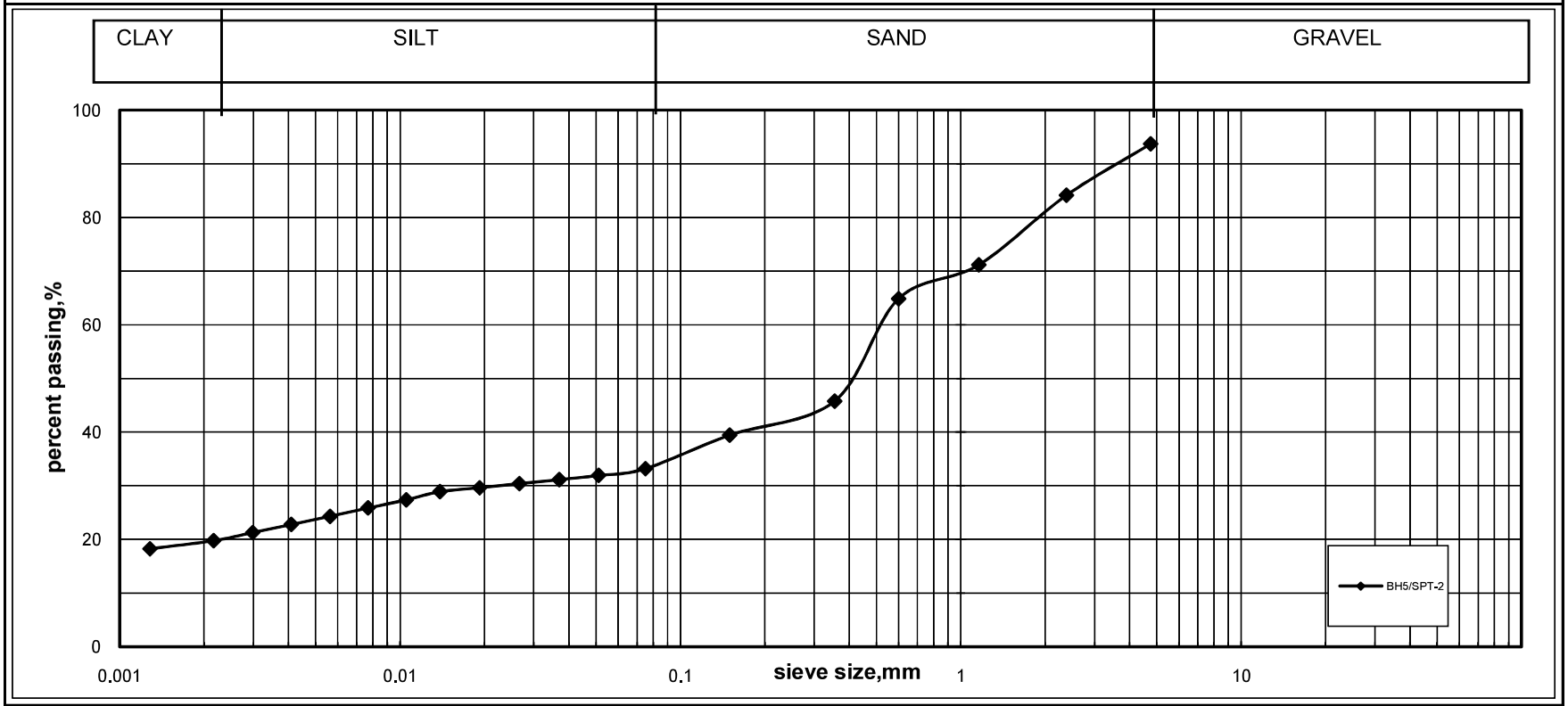
THE BOREHOLE IS TERMINATED AT 10.00m BELOW G.L.

BH NO. :	163	**EGL (EXISTING GROUND LEVEL)R.L.(+)(m)**	76.742
LOCATION :	N= -1413, E= 1173	**WATER TABLE below EGL (m) :**	3.90
		CASING Depth (m) :	1.00
START DATE :	4/24/2016	**BORING/ DRILLING METHOD :**	Rotary
END DATE :	4/26/2016	**DRILLING :** NX SIZE double tube core barrel	

Depth,m	RL, m	Graphical Log	Description	Sample		Penetration, cm			SPT N value	Core Recovery (CR)%	Rock Quality Designation (RQD)
				Depth	Type	15	30	45			
				m						%	%
0.00	76.74		Fresh pink , fine grained Limestone								
0.50	76.24										
1.00	75.74			0.75						80	80
1.50	75.24			1.50						80	73
2.00	74.74										
2.50	74.24										
3.00	73.74			3.00						94	82
3.50	73.24										
4.00	72.74										
4.50	72.24			4.50						96	96
5.00	71.74			5.00						74	52

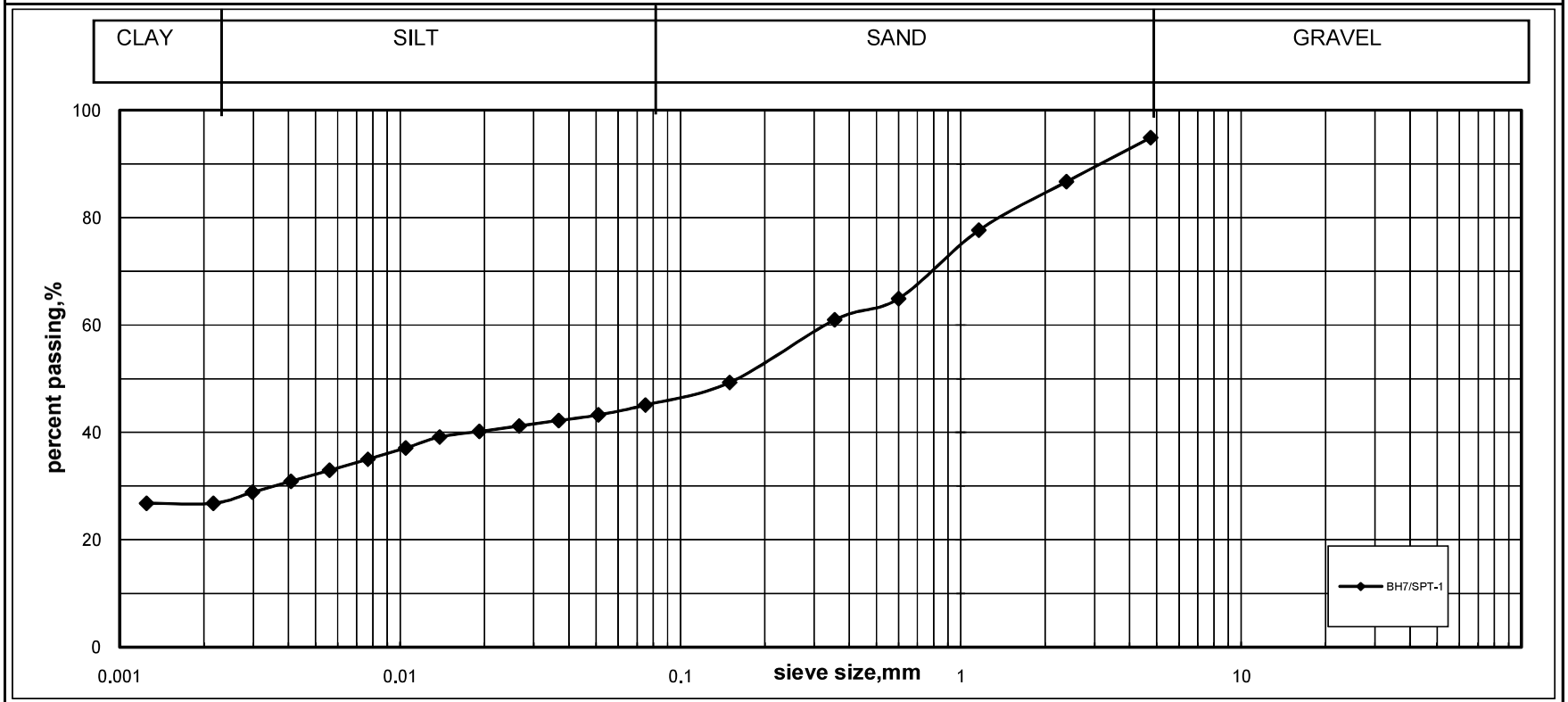
THE BOREHOLE IS TERMINATED AT 5.00m BELOW G.L.

GRAIN SIZE ANALYSIS



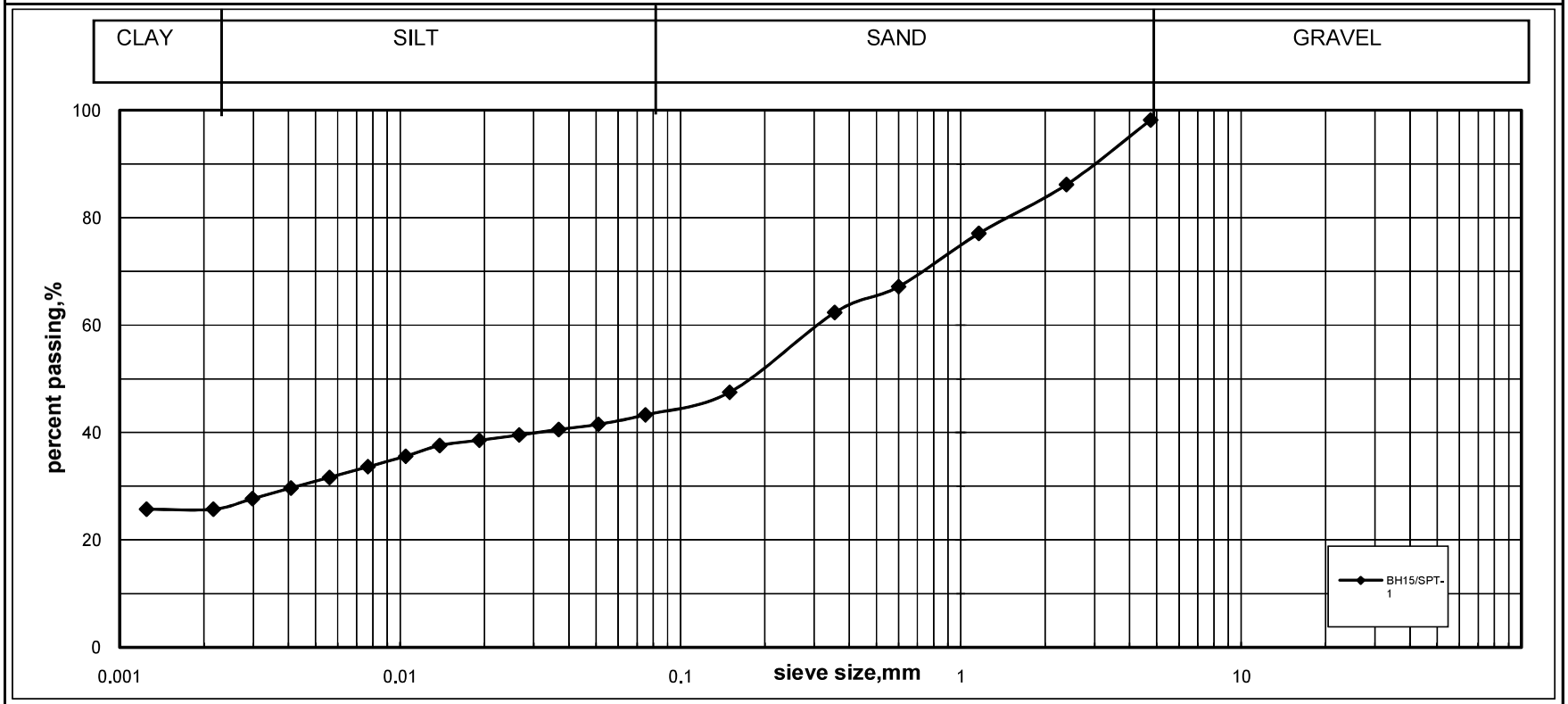
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
BH5/SPT-2	1.50	6.28	60.54	13.43	19.75	NP	NP	NP	NP	2.66	-	-

GRAIN SIZE ANALYSIS



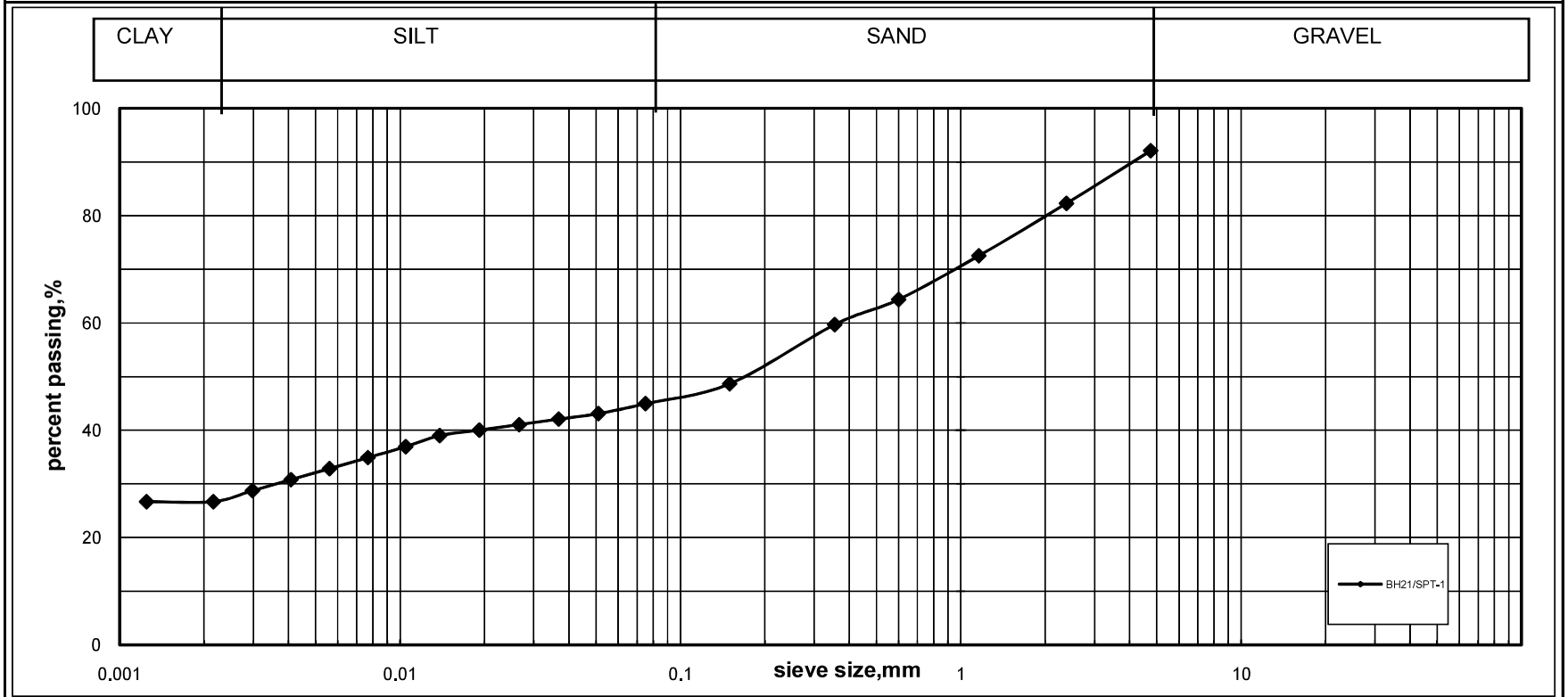
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
BH7/SPT-1	1.00	5.11	49.83	18.30	26.76	NP	NP	NP	NP	2.67	-	-

GRAIN SIZE ANALYSIS



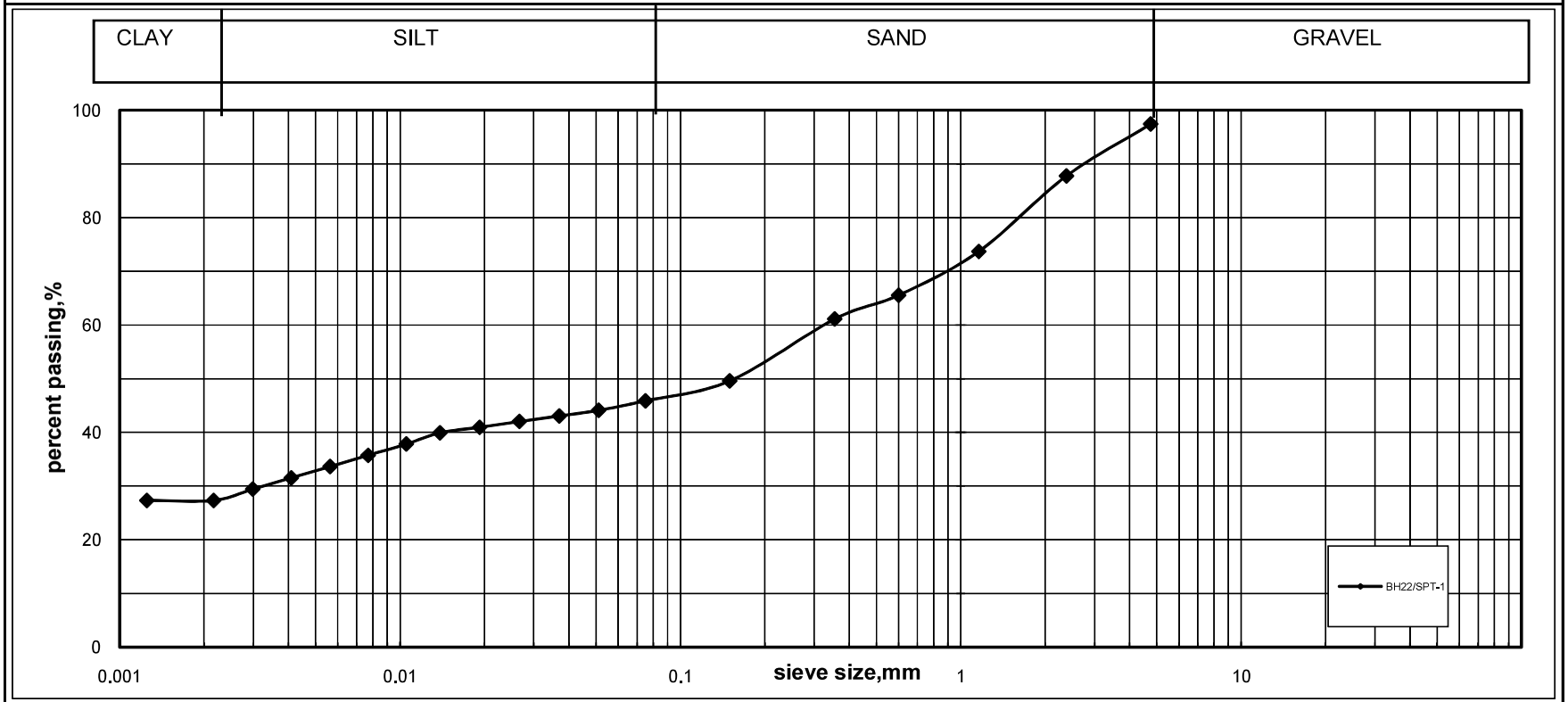
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
BH15/SPT-1	0.75	1.78	54.95	17.57	25.70	NP	NP	NP	NP	2.67	-	-

GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
BH21/SPT-1	1.00	7.93	47.14	18.25	26.68	NP	NP	NP	NP	2.67	-	-

GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
BH22/SPT-1	0.75	2.61	51.54	18.57	27.29	NP	NP	NP	NP	2.66	-	-

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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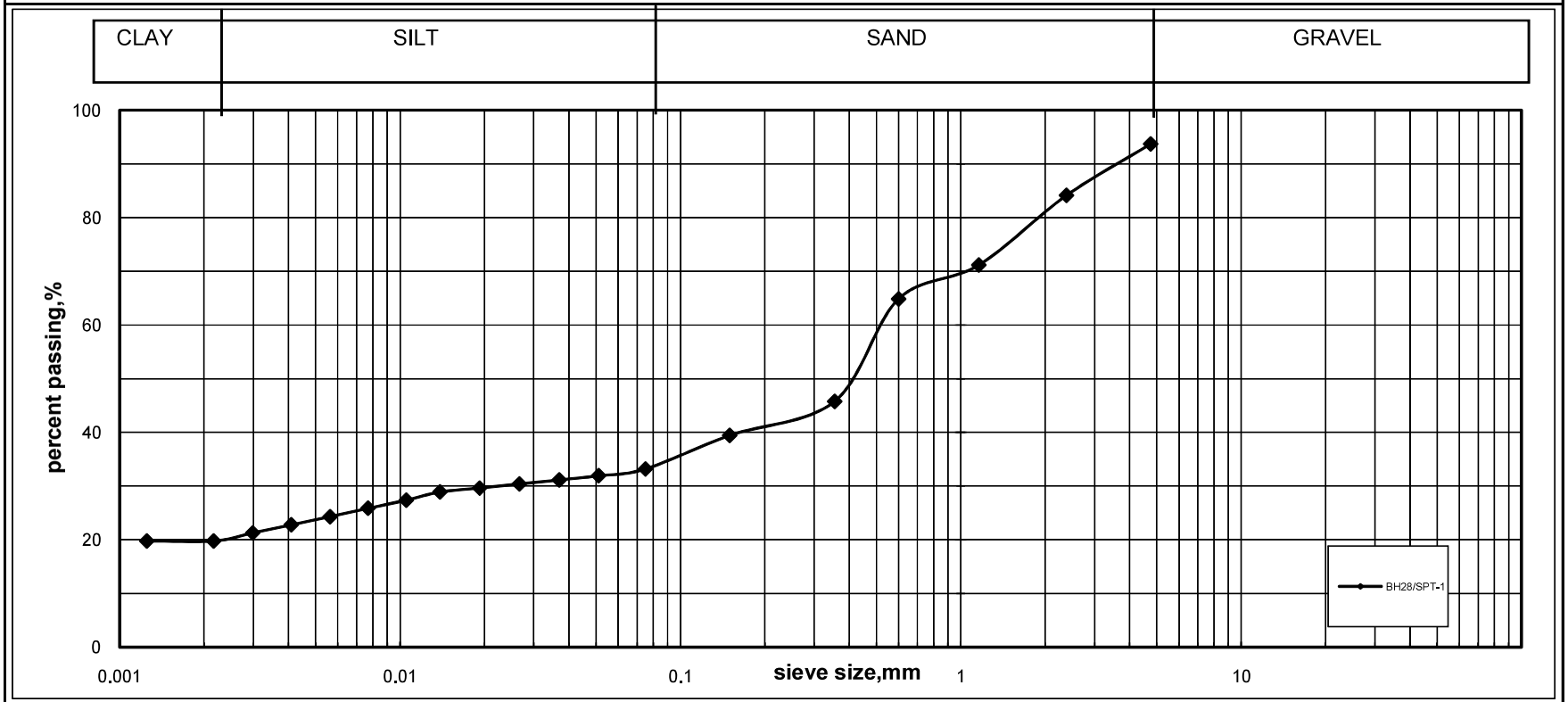
GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
BH28/SPT-1	0.75	6.28	60.54	13.43	19.75	NP	NP	NP	NP	2.66	-	-

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Noble Geo-Structs Project No. S 16022
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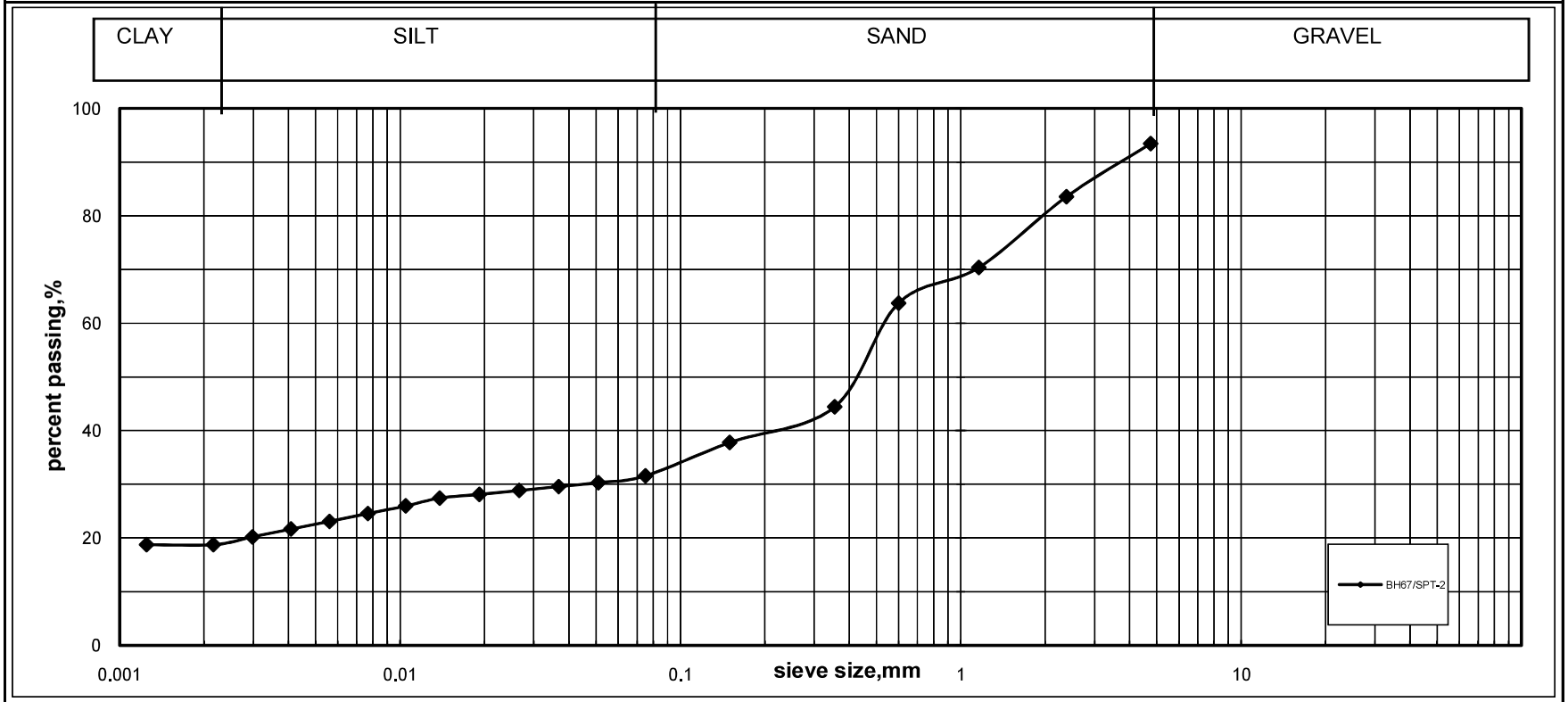
GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
BH67/SPT-2	1.50	6.55	61.89	12.82	18.74	NP	NP	NP	NP	2.67	-	-

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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Sr. No.	Borehole No.	Depth (m)	Core Piece No.	Water Absorption or Moisture content (%)	Specific Gravity	Hardness Mohs Scale	Soundness %	Porosity (%)	Dry Density (g/cc)	Slake Durability (I_d)	Point Load Index at in situ water content (kg/cm2)	Point Load Index at saturated water content (kg/cm2)	Deformability or Evalue (Mpa) at in situ water content	Deformability or Evalue (Mpa) at saturated water content	UCS (kg/cm^2) at in situ water content	UCS (kg/cm^2) at saturated water content	Core Description
1	1	2.25 to 3.00	11	0.13	2.60			1.15	2.57								Quartzite
2	1	8.25 to 9.75	92							15			1.46E+04		537		Shale
3	2	4.50 to 6.00	29			6	10				45						Quartzite
4	2	9.00 to 10.50	118							16				8.21E+03		294	Shale
5	3	4.50 to 6.00	32			7									1320		Quartzite
6	3	7.00 to 9.00	60				12					42					Limestone
7	3	13.50 to 15.00	123	0.32	2.52	7		1.19	2.49				1.70E+05		624		Limestone
8	4	3.75 to 4.50	23	0.25	2.60			1.15	2.57	17	31						Quartzite
9	5	5.25 to 6.00	43							18		67		1,622.E+04		1470	Quartzite
10	5	9.00 to 10.00	82				12								182		Shale
11	6	3.75 to 4.50	37	0.98	2.59	6		1.16	2.56						2090		Quartzite
12	6	6.00 to 7.50	69							20				1.16E+04		218	Shale
13	7	7.50 to 9.00	71				10				14				317		Shale
14	8	3.75 to 4.50	22	0.60	2.60	7		1.16	2.57	16							Quartzite
15	8	14.25 to 15.00	117				12				15			1.00E+04		309	Shale
16	9	7.50 to 9.00	81			7									174		Shale
17	9	13.50 to 15.00	167							18	25		1.45E+04		560		Shale
18	10	3.75 to 5.25	30				4					51	2.301.E+04			1098	Shale
19	10	8.25 to 9.75	93	0.46	2.65	4		1.13	2.62								Shale
20	11	4.50 to 6.00	43							20					747		Quartzite
21	12	6.00 to 7.50	56			7	12								1175		Quartzite
22	12	9.00 to 10.00	76								11			1.09E+04		232	Quartzite
23	13	1.50 to 2.25	14	1.45	2.54			1.18	2.51	22					78		Limestone
24	13	3.00 to 4.50	42			7					61				1345		Quartzite
25	13	13.50 to 15.00	198				12				14		1.16E+04		320		Shale
26	14	9.75 to 11.25	86									14	8.22E+03		287		Basalt
27	14	11.25 to 12.75	91	0.29	2.57			1.17	2.54								Basalt
28	15	4.50 to 6.00	53							15		73				1551	Limestone
29	15	9.00 to 10.00	94			7							1,478.E+04		1324		Quartzite
30	16	0.00 to 0.75	6	1.33	2.53		8	1.19	2.50						78		Limestone

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Noble Geo-Structs Project No. S 16022
June 7, 2016

Sr. No.	Borehole No.	Depth (m)	Core Piece No.	Water Absorption or Moisture content (%)	Specific Gravity	Hardness Mohs Scale	Soundness %	Porosity (%)	Dry Density (g/cc)	Slake Durability (I_d)	Point Load Index at in situ water content (kg/cm2)	Point Load Index at saturated water content (kg/cm2)	Deformability or Evalue (Mpa) at in situ water content	Deformability or Evalue (Mpa) at saturated water content	UCS (kg/cm^2) at in situ water content	UCS (kg/cm^2) at saturated water content	Core Description
31	16	1.50 to 2.25	34			3									75		Limestone
32	16	3.00 to 4.50	54							15					235		Limestone
33	16	9.00 to 10.00	124										1.429E+04		1462		Limestone
34	17	4.50 to 6.00	60			7	4				26					591	Quartzite
35	18	3.00 to 3.75	12	1.03	2.56			1.17	2.53	17					116		Limestone
36	18	3.75 to 5.25	30			5							1.523.E+04		1283		Sandstone
37	18	9.00 to 10.00	85				10			15					377		Basalt
38	19	3.00 to 4.50	19	0.76	2.66	7		1.13	2.63			10		8.210E+03		204	Quartzite
39	19	13.50 to 15.00	147							18					420		Shale
40	20	14.00 to 15.00	110				8				39			1.304E+04	860		Basalt
41	21	3.00 to 3.75	29			3									75		Limestone
42	21	9.00 to 10.00	85							16	11					233	Shale
43	22	3.00 to 3.75	12				11				21				151		Limestone
44	22	5.25 to 6.75	48	0.44	2.66		6	1.13	2.63								Quartzite
45	22	9.00 to 10.00	82			4				20				8.214E+03	211		Shale
46	23	1.50 to 2.25	11							15		24				505	Quartzite
47	23	9.00 to 10.50	125			6							7.326E+03		721		Quartzite
48	23	13.50 to 15.00	169	1.04	2.52		7	1.19	2.49						91		Quartzite
49	24	1.50 to 2.25	14			7						13			182		Limestone
50	24	9.00 to 10.00	86							18			1.200E+04		355		Shale
51	25	1.50 to 2.25	18				3				9			8.20E+03		196	Limestone
52	25	3.00 to 4.50	58	1.04	2.54	3		1.18	2.51						128		Limestone
53	25	7.50 to 9.00	108								64			1.26E+04	1402		Quartzite
54	26	3.00 to 3.75	15				11			20					142		Limestone
55	26	4.50 to 6.00	35			4									711		Limestone
56	27	0.75 to 1.50	15			30				15					219		Limestone
57	27	2.25 to 3.75	49	0.83	2.61		8	1.15	2.58			10	1.46E+04		220		Limestone
58	28	3.75 to 4.50	21										1.67E+04		1562		Quartzite
59	28	12.75 to 14.25	145				12								473		Shale
60	29	1.50 to 2.25	33			7										128	Limestone

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Sr. No.	Borehole No.	Depth (m)	Core Piece No.	Water Absorption or Moisture content (%)	Specific Gravity	Hardness Mohs Scale	Soundness %	Porosity (%)	Dry Density (g/cc)	Slake Durability (I_d)	Point Load Index at in situ water content (kg/cm2)	Point Load Index at saturated water content (kg/cm2)	Deformability or Evalue (Mpa) at in situ water content	Deformability or Evalue (Mpa) at saturated water content	UCS (kg/cm^2) at in situ water content	UCS (kg/cm^2) at saturated water content	Core Description
61	29	6.75 to 8.25	67	3.33	2.53			1.32	2.25	15				1.51E+05		340	Limestone
62	30	12.00 to 13.5	418			4									754		Shale
63	30	4.50 to 5.25	35				7			18	76			1.54E+04		1718	Quartzite
64	31	10.50 to 12.00	107												1520		Shale
65	31	15.00 to 16.50	163			7							1.67E+04		1252		Shale
66	31	18.00 to 19.50	197	0.54	2.67		10	1.12	2.64						400		Shale
67	32	4.50 to 6.00	42	0.77	2.63			1.14	2.60	17	11			1.09E+04		233	Quartzite
68	33	2.25 to 3.00	12				5									218	Limestone
69	33	17.25 to 18.75	170								37		1.25E+05		987		Shale
70	34	0.75 to 2.29	8				2			15					88		Limestone
71	34	5.25 to 6.75	53	0.17	2.65	4		1.05	2.62			76				1635	Quartzite
72	35	0.00 to 0.75	1			6	11										Quartzite
73	35	2.25 to 3.00	3								20		1.92E+04		835		Quartzite
74	36	0.75 to 1.50	4				12										Quartzite
75	36	3.00 to 3.75	7									32					Quartzite
76	37	2.25 to 3.00	11			7									985		Quartzite
77	37	8.25 to 9.75	86							20		52				1109	Quartzite
78	37	14.25 to 15.00	134	0.32	2.62		12	0.61	2.61								Quartzite
79	38	1.50 to 2.25	8							23				5.53E+03		277	Quartzite
80	38	4.50 to 5.25	12	0.34	2.56			1.17	2.53		37						Quartzite
81	39	3.00 to 3.75	21			6										1164	Quartzite
82	39	9.00 to 10.00	94							15					371		Shale
83	40	1.50 to 2.25	6			7	10								1013		Quartzite
84	41	2.25 to 3.00	4										1.33E+04		370		Quartzite
85	41	3.75 to 4.50	9							18						1064	Quartzite
86	42	2.25 to 3.00	20				6				36						Limestone
87	43	3.75 to 4.50	28				7						1.46E+04		577		Quartzite
88	44	3.75 to 4.50	17	1.65	2.45		8	1.22	2.42					1.30E+04		350	Quartzite
89	45	3.75 to 4.50	15	0.65	2.61			1.15	2.58								Limestone
90	46	1.50 to 2.25	9	0.35	2.63		14	1.14	2.60								Limestone

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91	46	2.25 to 3.00	12							16				1.724E+04		1154	Limestone
92	47	6.75 to 7.50	45							19	42						Shale
93	47	8.25 to 9.00	56			4	10					46					Shale
94	48	2.25 to 3.00	11	0.78	2.54	3		1.23	2.41								Quartzite
95	49	2.25 to 3.00	13							22	29						Quartzite
96	50	2.25 to 3.00	17								24						Limestone
97	50	7.50 to 9.00	62			30				22							Limestone
98	51	2.25 to 3.00	8							15						975	Quartzite
99	51	12.00 to 13.50	134	0.29	2.57	7		1.17	2.54					1.15E+04			Shale
100	52	2.25 to 3.00	18				6								1170		Quartzite
101	52	9.00 to 10.00	71							21			1.67E+04		1542		Quartzite
102	53	1.50 to 2.25	3				4					22					Quartzite
103	54	8.25 to 9.00	99			30	9								644		Limestone
104	55	4.50 to 5.25	22	0.14	2.56	6		1.17	2.53								Quartzite
105	56	3.75 to 5.25	40				4			15		56	1.44E+04			1233	Limestone
106	56	13.50 to 15.00	165												360		Limestone
107	57	4.50 to 5.25	21			7	11							1.74E+04			Quartzite
108	58	9.00 to 9.75	57				13							2.857E+03		241	Limestone
109	58	12.75 to13.50	83	0.67	2.53			1.19	2.50		11						Limestone
110	59	7.50 to 8.25	39			6	10										Quartzite
111	59	9.00 to 9.75	45	0.44	2.58			1.16	2.55	15							Quartzite
112	60	7.50 to 8.25	26			6	12									897	Quartzite
113	61	0.75 to 1.50	10			7									130		Quartzite
114	61	2.25 to 3.00	20	1.69	2.54			1.34	2.21	15							Quartzite
115	61	6.75 to 8.25	62				8									1142	Shale
116	62	6.75 to 7.50	50											1.43E+04		1151	Shale
117	62	7.50 to 9.00	64			5	12										Shale
118	63	4.50 to 5.25	42	0.29	2.57			1.22	2.44	21			1.96E+04				Limestone
119	64	0.75 to 1.50	4			29	4								134		Limestone
120	64	6.75 to 7.50	47			7					55		1.26E+04		1216		Shale

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121	64	9.00 to 9.75	81	1.63	2.52			1.35	2.19	18							Shale
122	65	3.75 to 4.50	25							15							Limestone
123	65	4.50 to 5.25	27								29						Limestone
124	66	0.75 to 1.50	7				11						1.60E+04		807		Limestone
125	67	9.75 to 10.50	70				10					39				1065	Shale
126	68	3.00 to 3.75	31	0.45	2.50			1.20	2.47						113		Limestone
127	68	7.50 to 9.00	91							16	27						Shale
128	69	2.25 to 3.00	15			4									211		Limestone
129	69	13.50 to 15.00	146	0.42	2.51		12	1.20	2.48	22		17		1.30E+04		143	Shale
130	70	2.25 to 3.00	32										1.67E+04		1088		Limestone
131	70	3.75 to 4.50	44			30	7					32					Limestone
132	71	6.00 to 7.50	46	0.30	2.62			1.14	2.59	15							Limestone
133	71	7.50 to 9.00	56			7					38			1.30E+04		981	Limestone
134	72	1.50 to 2.25	16	0.30	2.77	3		1.08	2.74			56		1.44E+04		1163	Limestone
135	73	0.00 to 0.75	3	1.70	2.54			1.18	2.51	19							Limestone
136	75	3.00 to 3.75	16	0.52	2.51			1.30	2.28	16						128	Shale
137	76	3.00 to 4.50	13	0.82							32						Quartzite
138	77	4.50 to 5.25	49				12				22				478		Limestone
139	77	9.75 to 11.25	129			28							1.67E+04				Limestone
140	78	3.00 to 4.50	44				5			20			8.23E+03		204		Limestone
141	78	6.00 to 7.50	86			4								1.30E+04			Limestone
142	78	13.50 to 15.00	151	0.83	2.54		10	1.23	2.41								Limestone
143	79	1.50 to 2.25	19							18			5.53E+03		233		Limestone
144	79	8.25 to 9.75	133			3					88						Limestone
145	80	2.25 to 3.00	30				11								549		Limestone
146	80	6.00 to 7.50	75							19				1.15E+04		770	Quartzite
147	80	10.50 to 12.00	132	0.27	2.55			1.18	2.52								Quartzite
148	81	2.25 to 3.00	23	0.31	2.61	4		1.15	2.58							218	Shale
149	82	3.75 to 4.50	43	0.73	2.52			1.19	2.49	17		52				1109	Limestone
150	83	1.50 to 2.25	9				9			20	17						Limestone

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151	83	3.25 to 4.50	21	0.30	2.55			1.18	2.52				1.932E+04		558		Limestone
152	84	6.75 to 7.50	53	0.33	2.59		6	1.16	2.56					1.54E+04		1164	Shale
153	85	9.00 to 10.00	89			3							8.21E+03		226		Limestone
154	86	1.50 to 2.25	12								15				331		Quartzite
155	86	8.25 to 9.00	65							17	28		1.67E+04		2505		Quartzite
156	86	13.50 to 15.00	127	0.48	2.51		8	1.20	2.48								Quartzite
157	87	2.25 to 3.00	26				7			15							Limestone
158	87	3.75 to 4.50	39			29						26					Limestone
159	88	3.00 to 3.75	27	0.32	2.55	4		1.18	2.52			39				1065	Limestone
160	89	6.15 to 4.50	38	0.59	2.57		7	1.22	2.44	16	70		1.67E+04		1542		Quartzite
161	90	1.50 to 2.25	11												70		Limestone
162	90	12.00 to 12.75	88							15	31		1.46E+05		694		Shale
163	91	0.75 to 1.50	6	1.78	2.54	3		1.40	2.51								Limestone
164	91	1.50 to 2.25	23				5			16					121		Limestone
165	91	9.00 to 10.50	83B									41		1.54E+04		1090	Quartzite
166	92	3.00 to 3.75	38	0.71	2.50	4		1.20	2.47						158		Limestone
167	93	2.25 to 3.00	16			30				20							Limestone
168	93	3.00 to 4.50	23	0.30	2.62			1.15	2.59								Limestone
169	94	0.00 to 0.75	2									44					Limestone
170	94	3.00 to 3.75	19							15							Limestone
171	95	0.75 to 1.50	5										1.429E+04		1147		Limestone
172	95	2.25 to 3.00	14			28	4			22							Limestone
173	96	3.00 to 4.50	48							22				8.21E+03		234	Limestone
174	97	1.50 to 2.25	23				8								113		Limestone
175	97	6.00 to 7.50	74	0.44	2.54	3		1.18	2.51								Quartzite
176	97	7.50 to 9.00	106							20	19		1.66E+05		386		Quartzite
177	97	13.50 to 15.00	141			7	10									576	Quartzite
178	98	3.00 to 3.75	21	1.01	2.65			1.13	2.62								Limestone
179	98	3.75 to 4.50	31							21							Limestone
180	99	4.50 to 6.00	72			4					27				596		Limestone

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181	100	3.00 to 3.75	57	0.29	2.57		11	1.17	2.54							106	Limestone
182	100	7.50 to 9.00	125							15		32	1.75E+04				Quartzite
183	101	4.50 to 6.00	90				12								143		Limestone
184	102	2.25 to 3.00	20			3								7.48E+04		196	Limestone
185	102	9.00 to 10.00	114	0.29	2.56			1.22	2.43								Quartzite
186	103	0.75 to 4.50	5							18				1.43E+04		1193	Limestone
187	103	2.25 to 3.00	11			30	4										Limestone
188	104	7.50 to 9.00	66							18	40			1.24E+04		853	Limestone
189	105	3.00 to 3.75	10	0.74	2.60			1.15	2.57								Limestone
190	105	4.50 to 6.00	12							20							Limestone
191	106	2.25 to 3.00	27	0.68	2.64			1.14	2.61					7.48E+04		128	Shale
192	106	4.50 to 5.25	51	0.34	2.56	4	9	1.17	2.53		37		1.25E+05		702		Shale
193	107	3.00 to 3.75	20			4									106		Limestone
194	108	1.50 to 2.25	4										1.15E+04		702		Limestone
195	108	3.00 to 3.75	5							15							Limestone
196	109	1.50 to 2.25	6	0.68	2.64			1.14	2.61				8.22E+03		241		Quartzite
197	109	3.00 to 3.75	15				8				28						Limestone
198	110	0.75 to 1.50	5	1.64	2.64			1.13	2.61								Quartzite
199	110	6.00 to 6.75	23			7				20						400	Quartzite
200	111	2.75 to 3.50	9	0.80	2.65			1.13	2.62								Quartzite
201	111	8.00 to 8.75	32							24							Quartzite
202	112	1.50 to 2.25	5	0.49	2.52		11	1.10	2.69								Quartzite
203	113	6.00 to 6.75	10				10			16							Quartzite
204	113	6.75 to 7.50	11			7	12										Quartzite
205	114	6.00 to 7.50	47							20	20				521		Shale
206	114	9.00 to 10.00	75	0.53	2.62			1.14	2.59								Shale
207	115	3.00 to 3.75	9							17							Quartzite
208	115	12.00 to 12.75	50											1.60E+04		1120	Limestone
209	116	3.00 to 3.75	9			7	11				42						Quartzite
210	116	6.75 to 7.50	27	1.14	2.53			1.19	2.50	22							Quartzite

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211	117	6.75 to 7.50	31				7			18			1.67E+04			1539	Quartzite
212	118	2.25 to 3.00	18			3					55				1207		Limestone
213	118	13.50 to 15.00	152							23	51		1.60E+04		1071		Limestone
214	118	13.50 to 15.00	152			30	4										Limestone
215	119	4.50 to 6.00	31							17		46				1216	Limestone
216	119	6.00 to 7.50	53	0.39	2.58	4		1.16	2.55								Limestone
217	120	2.25 to 3.00	16			7	9										Quartzite
218	120	3.75 to 4.50	27							18							Quartzite
219	121	2.25 to 3.00	12							15							Quartzite
220	121	5.25 to 6.75	30			7							1.88E+04		1044		Quartzite
221	122	4.50 to 5.25	31	0.30	2.53		4	1.19	2.50	15						1086	Quartzite
222	122	7.50 to 9.00	55			7								1.67E+04			Quartzite
223	123	3.75 to 4.50	27	0.60	2.59			1.16	2.56	22		67	1.622.E+04			1325	Quartzite
224	124	3.00 to 3.75	13							16							Quartzite
225	124	3.75 to 4.50	15			6					38						Quartzite
226	125	4.50 to 5.25	23	0.43	2.51			1.20	2.48		50		1.26E+04		1120		Quartzite
227	125	6.00 to 6.75	33	0.60	2.66	7		1.13	2.63						355		Quartzite
228	126	4.50 to 5.25	29	0.30	2.53		6	1.18	2.50								Quartzite
229	127	7.50 to8.25	54	0.67	2.63			1.14	2.60	20	31			1.09E+04		246	Quartzite
230	128	1.50 to 2.25	7	0.40	2.65			1.13	2.62								Limestone
231	128	3.75 to 4.50	14							22							Limestone
232	129	0.75 to 1.50	10								27						Limestone
233	129	2.25 to 3.00	19			30								1.43E+04		379	Limestone
234	130	9.00 to 10.00	98A & 98B	0.43	2.63	4		1.14	2.60						279		Limestone
235	131	9.00 to 10.00	63				8					56	1.60E+04			1230	Limestone
236	132	0.00 to 0.75	2			29	5										Limestone
237	132	1.50 to 3.00	7				11			27							Limestone
238	133	2.25 to 3.00	10				5									427	Quartzite
239	134	4.50 to 5.25	49	0.44	2.68			1.12	2.65	18			1.46E+05		520		Quartzite
240	135	3.75 to 4.50	38	0.36	2.54	4		1.18	2.51					8.21E+03		264	Shale

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Noble Geo-Structs Project No. S 16022
June 7, 2016

Sr. No.	Borehole No.	Depth (m)	Core Piece No.	Water Absorption or Moisture content (%)	Specific Gravity	Hardness Mohs Scale	Soundness %	Porosity (%)	Dry Density (g/cc)	Slake Durability (I_d)	Point Load Index at in situ water content (kg/cm2)	Point Load Index at saturated water content (kg/cm2)	Deformability or Evalue (Mpa) at in situ water content	Deformability or Evalue (Mpa) at saturated water content	UCS (kg/cm^2) at in situ water content	UCS (kg/cm^2) at saturated water content	Core Description
241	136	6.00 to 7.50	45	0.32	2.78		10	1.08	2.75				1.67E+04		1345		Shale
242	136	9.00 to 7.50	90	0.43	2.64	4	10	1.14	2.61								Shale
243	137	5.25 to 6.00	24	0.99	2.56			1.17	2.53	15					142		Shale
244	138	3.00 to 3.75	14							22							Quartzite
245	138	3.75 to 4.50	18	1.15	2.61			1.15	2.58								Quartzite
246	139	0.75 to 1.50	3				9						1.30E+04				Quartzite
247	140	2.25 to 3.00	8			6	12										Quartzite
248	140	4.50 to 5.25	23			7	9			15							Quartzite
249	141	0.75 to 1.50	12				2					33					Limestone
250	142	1.50 to 2.25	6	0.32	2.76			1.09	2.73								Limestone
251	143	9.00 to 10.00	91			3									633		Limestone
252	144	7.50 to 9.00	90	0.33	2.70		8	1.11	2.67		28			1.15E+04		596	Limestone
253	145	3.75 to 5.25	39							18			1.54E+04		1056		Limestone
254	145	12.75 to 14.25	135				12								1298		Limestone
255	146	2.25 to 3.75	19			4									1253		Limestone
256	146	6.75 to 8.25	71	0.47	2.66			1.13	2.63	15		18	1.20E+04			377	Limestone
257	147	3.00 to 3.75	25				12								781		Limestone
258	147	11.25 to 12.75	84			3				20		34	1.15E+04		757		Limestone
259	148	3.00 to 4.50	32	0.15	2.73		7	1.10	2.70						943		Limestone
260	148	9.00 to 10.00	67							17	37			1.15E+04		789	Limestone
261	149	2.25 to 3.75	16								44				963		Limestone
262	149	8.25 to 9.75	67			4					35				775		Limestone
263	150	3.00 to 3.75	15							16							Limestone
264	150	4.50 to 5.25	21	0.77	2.62			1.15	2.59								Limestone
265	151	2.25 to 3.00	20	0.45	2.50			1.20	2.47	18							Limestone
266	151	4.50 to 6.00	46											1.57E+04		1064	Limestone
267	152	3.25 to 4.50	32	0.34	2.57		6	1.17	2.54		28		1.67E+04		2055		Shale
268	152	4.50 to 6.00	38	0.32	2.54			1.09	2.51	18	53				1175		Shale
269	153	7.50 to 8.25	76				3						7.73E+03				Quartzite
270	154	3.00 to 3.75	15							18							Limestone

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Noble Geo-Structs Project No. S 16022
June 7, 2016

Sr. No.	Borehole No.	Depth (m)	Core Piece No.	Water Absorption or Moisture content (%)	Specific Gravity	Hardness Mohs Scale	Soundness %	Porosity (%)	Dry Density (g/cc)	Slake Durability (I_d)	Point Load Index at in situ water content (kg/cm2)	Point Load Index at saturated water content (kg/cm2)	Deformability or Evalue (Mpa) at in situ water content	Deformability or Evalue (Mpa) at saturated water content	UCS (kg/cm^2) at in situ water content	UCS (kg/cm^2) at saturated water content	Core Description
271	154	5.25 to 6.00	29			29						36	1.16E+04		247		Limestone
272	155	1.5 to 2.25	11	0.49	2.65	4		1.13	2.62		16				360		Shale
273	156	0.75 to 1.50	3				12					11					Limestone
274	157	10.50 to 11.25	72								62						Limestone
275	157	14.25 to 15.00	101							14							Limestone
276	158	0.75 to 1.50	5							23							Limestone
277	158	2.25 to 3.00	10			30	4										Limestone
278	159	0.00 to 0.75	1							16							Limestone
279	159	1.50 to 2.25	7			30	3					23					Limestone
280	160	5.25 to 6.00	35	1.23	2.53			1.19	2.50	15					75		Shale
281	161	8.25 to 9.00	28			7								1.55E+04		1622	Quartzite
282	161	9.75 to 10.50	34								53						Quartzite
283	162	8.25 to 9.00	13			30					44						Limestone
284	163	0.00 to 0.75	3	0.45	2.50		5	1.20	2.47								Limestone

Date : 10.03.2016.

Name of the Client	**Bharat Heavy Electricals Limited**
Nature of the Sample	Water
Project	Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Results of Analysis	***W a t e r*** ***BH 20***	Depth (m): 4.00
Total Carbonates (as CaCO3)	154	**ppm**
Sulphate (as SO4)	34	**ppm**
Sulphite (as SO3)	28.33	**ppm**
Chloride (as Cl)	110	**ppm**
Nitrate (as NO3)	0.032	**ppm**
Nitrite (as NO2)	0.024	**ppm**
p H Value (By Digital p H Meter)	7.63	**6.50 – 8.30**
Turbidity (as N T U)	350	**max 1000**
Total Organic matter	54	**ppm**

Date : 10.03.2016.

Name of the Client	**Bharat Heavy Electricals Limited**
Nature of the Sample	Water
Project	Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Results of Analysis	***W a t e r*** ***BH 50***	Depth (m): 4.00
Total Carbonates (as CaCO3)	150	**ppm**
Sulphate (as SO4)	35	**ppm**
Sulphite (as SO3)	29.17	**ppm**
Chloride (as Cl)	111	**ppm**
Nitrate (as NO3)	0.034	**ppm**
Nitrite (as NO2)	0.025	**ppm**
p H Value (By Digital p H Meter)	7.71	**6.50 – 8.30**
Turbidity (as N T U)	355	**max 1000**
Total Organic matter	51	**ppm**

Date : 10.03.2016.

Name of the Client	**Bharat Heavy Electricals Limited**
Nature of the Sample	Water
Project	Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Results of Analysis	***W a t e r*** ***BH 74***	Depth (m): 3.00
Total Carbonates (as CaCO3)	160	**ppm**
Sulphate (as SO4)	41	**ppm**
Sulphite (as SO3)	34.17	**ppm**
Chloride (as Cl)	121	**ppm**
Nitrate (as NO3)	0.039	**ppm**
Nitrite (as NO2)	0.029	**ppm**
p H Value (By Digital p H Meter)	7.82	**6.50 – 8.30**
Turbidity (as N T U)	360	**max 1000**
Total Organic matter	56	**ppm**

Date : 10.03.2016.

Name of the Client	**Bharat Heavy Electricals Limited**
Nature of the Sample	Water
Project	Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Results of Analysis	***W a t e r*** ***BH 110***	Depth (m): 5.00
Total Carbonates (as CaCO3)	160	**ppm**
Sulphate (as SO4)	44	**ppm**
Sulphite (as SO3)	36.67	**ppm**
Chloride (as Cl)	127	**ppm**
Nitrate (as NO3)	0.044	**ppm**
Nitrite (as NO2)	0.033	**ppm**
p H Value (By Digital p H Meter)	7.87	**6.50 – 8.30**
Turbidity (as N T U)	387	**max 1000**
Total Organic matter	61	**ppm**

Date : 10.03.2016.

Name of the Client	**Bharat Heavy Electricals Limited**
Nature of the Sample	Water
Project	Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Results of Analysis	***W a t e r*** ***BH 118***	Depth (m): 6.50
Total Carbonates (as CaCO3)	163	**ppm**
Sulphate (as SO4)	43	**ppm**
Sulphite (as SO3)	35.83	**ppm**
Chloride (as Cl)	124	**ppm**
Nitrate (as NO3)	0.041	**ppm**
Nitrite (as NO2)	0.030	**ppm**
p H Value (By Digital p H Meter)	7.68	**6.50 – 8.30**
Turbidity (as N T U)	362	**max 1000**
Total Organic matter	59	**ppm**

Date : 10.03.2016.

Name of the Client	**Bharat Heavy Electricals Limited**
Nature of the Sample	Water
Project	Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Results of Analysis	***W a t e r*** ***BH 140***	Depth (m): 3.80
Total Carbonates (as CaCO3)	151	**ppm**
Sulphate (as SO4)	30	**ppm**
Sulphite (as SO3)	25.00	**ppm**
Chloride (as Cl)	108	**ppm**
Nitrate (as NO3)	0.028	**ppm**
Nitrite (as NO2)	0.021	**ppm**
p H Value (By Digital p H Meter)	7.3	**6.50 – 8.30**
Turbidity (as N T U)	333	**max 1000**
Total Organic matter	49	**ppm**

BH. NO.	Depth	Sulphate (as SO4)	Chloride (as Cl)	p H Value (By Digital p H Meter)
	(m)	%	%	6.50 – 8.30
BH 15	1.00	0.027	0.180	7.650
BH 21	1.00	0.032	0.160	7.800
BH 22	1.00	0.030	0.170	7.560
BH 28	1.00	0.033	0.160	7.560
BH 67	1.00	0.036	0.150	7.300

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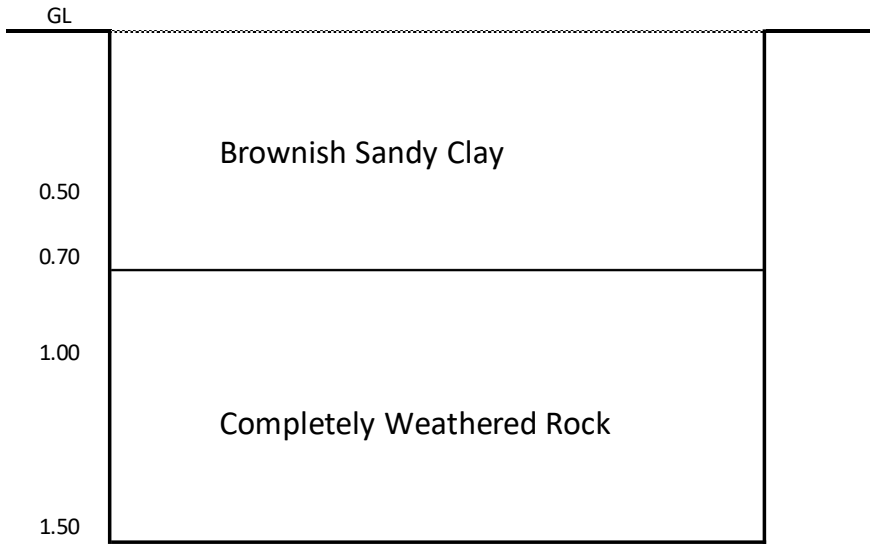
Noble Geo-Structs Project No. S 16022
June 7, 2016

TRIAL PIT LOG NO ---1-

Trial pit no:	TP-1			Date :	3/6/2016
Location	N = 851		E = 194	Depth. m:	1.5
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		89.628



Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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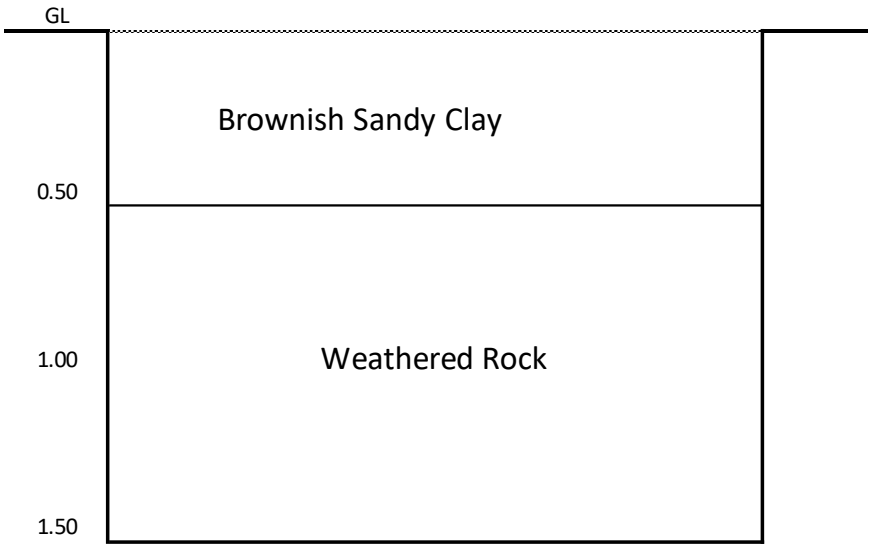
June 7, 2016

TRIAL PIT LOG NO ---2

Trial pit no:	TP-2			Date :	3/6/2016
Location	N = 357		E = 445	Depth, m:	1.5
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		89.628



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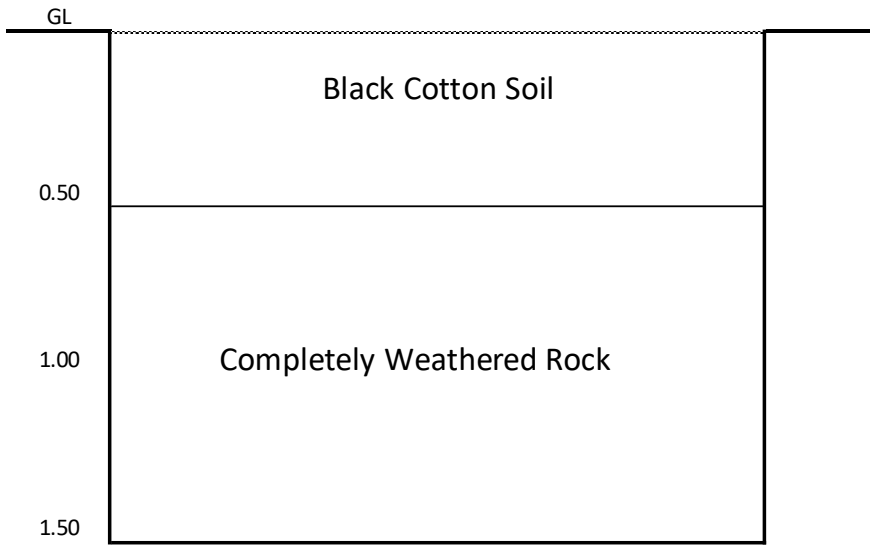
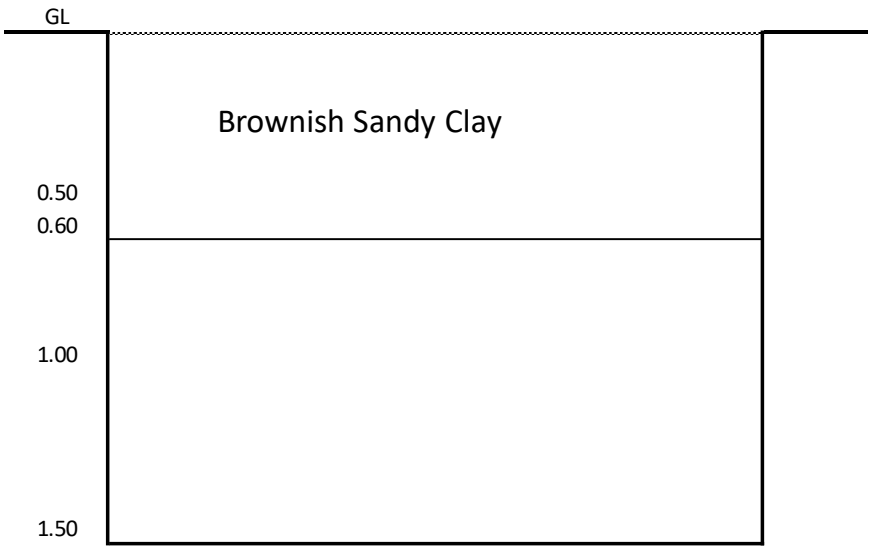
TRIAL PIT LOG NO --3

Trial pit no:	TP-3			Date :	3/6/2016
Location	N = -64		E = -29	Depth, m:	1.5
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		78.598



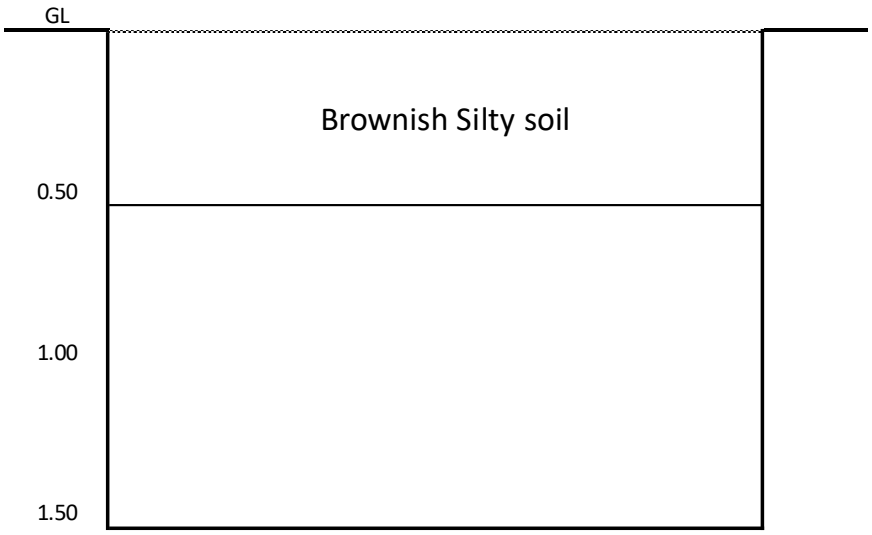
TRIAL PIT LOG NO --4

Trial pit no:	TP-4			Date :	3/6/2016
Location	N = -64		E = 99	Depth, m:	0.6
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		79.902



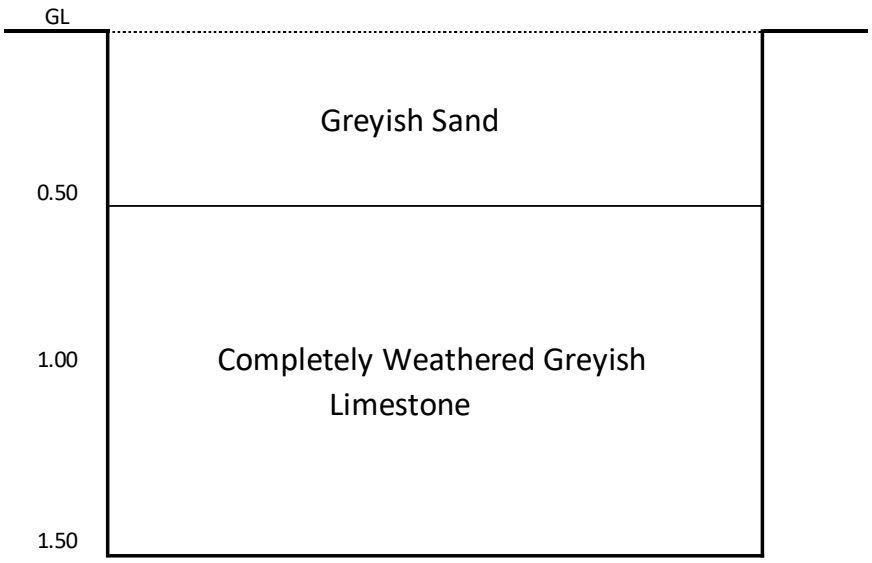
TRIAL PIT LOG NO --5

Trial pit no:	TP-5			Date :	3/6/2016
Location	N = -64		E = 396	Depth, m:	0.5
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		82.228



TRIAL PIT LOG NO --6

Trial pit no:	TP-6			Date :	3/6/2016
Location	N = -64		E = 659	Depth. m:	1.5
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		86.028



Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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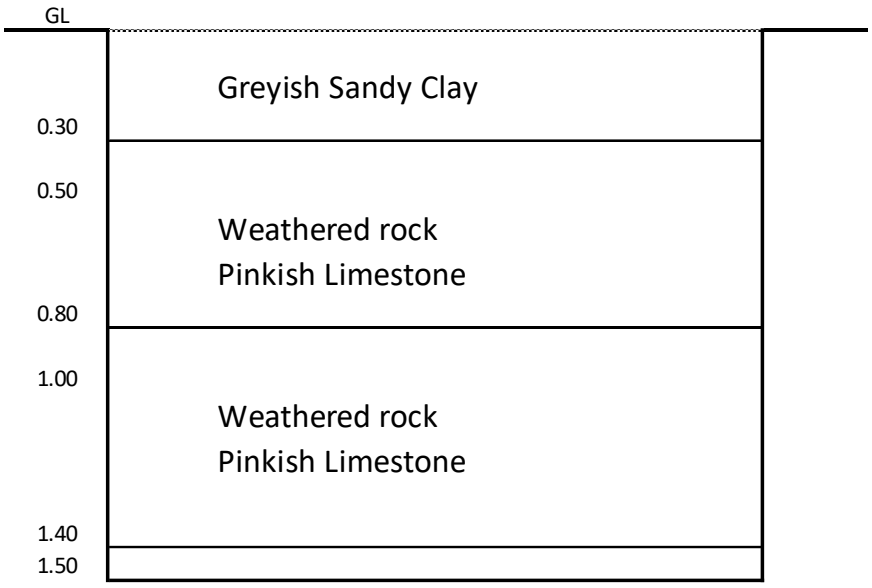
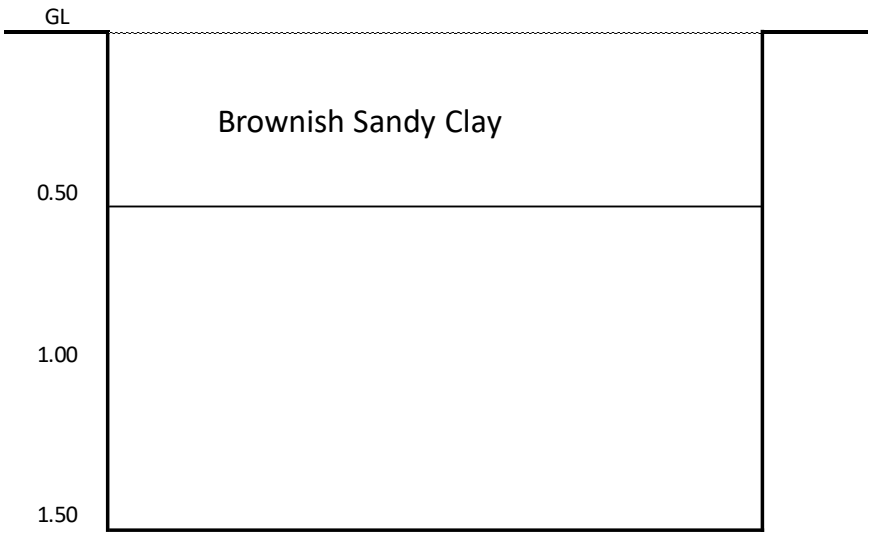
TRIAL PIT LOG NO --7

Trial pit no:	TP-7			Date :	3/6/2016
Location	N = -236		E = 236	Depth, m:	1.4
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		82.038



TRIAL PIT LOG NO --8

Trial pit no:	TP-8			Date :	3/6/2016
Location	N = -748		E = 1309	Depth. m:	0.5
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		82.89



Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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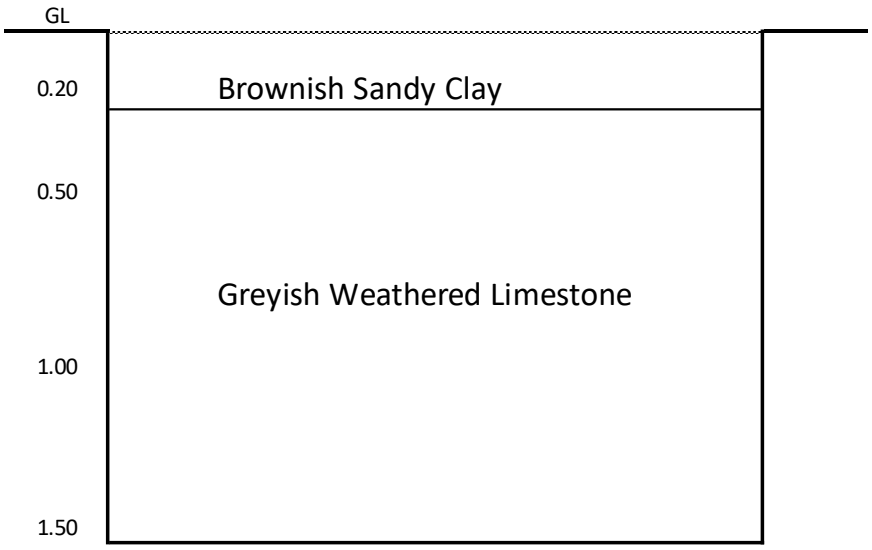
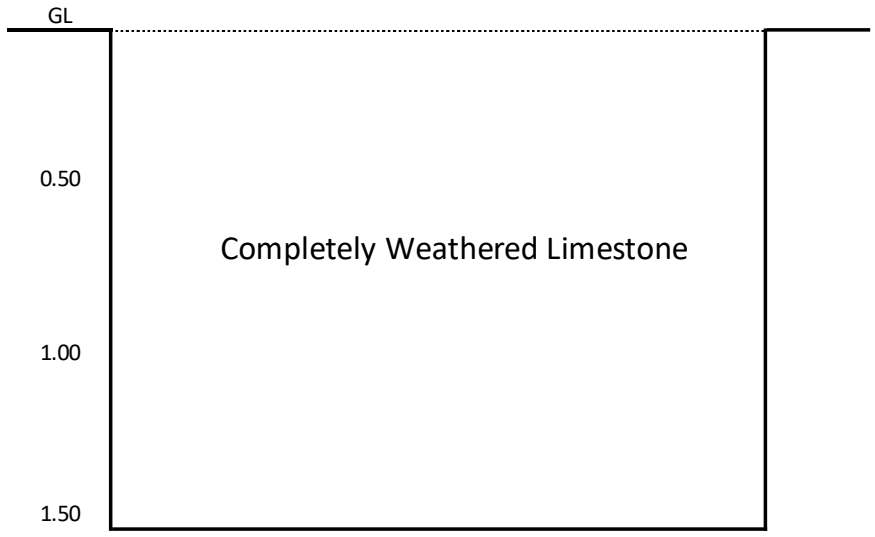
TRIAL PIT LOG NO ---9

Trial pit no:	TP-9			Date :	3/6/2016
Location	N = -32		E = 931	Depth, m:	1.5
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		86.572



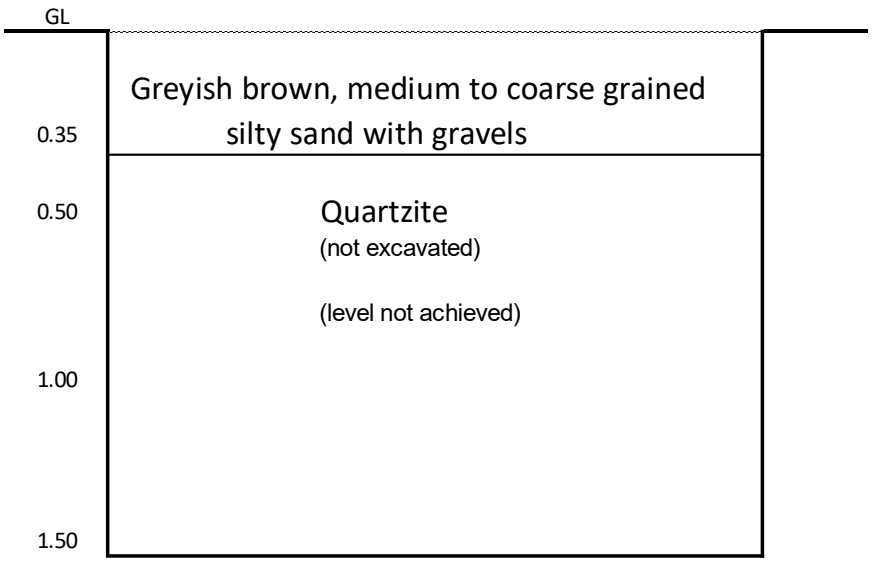
TRIAL PIT LOG NO ---10

Trial pit no:	TP-10			Date :	3/6/2016
Location	N = -318		E = 1693	Depth, m:	1.5
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		88.515



TRIAL PIT LOG NO --11

Trial pit no:	TP-11			Date :	27/01/2016
Location	N = 280		E = 1	Depth. m:	0.35
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		78.505



Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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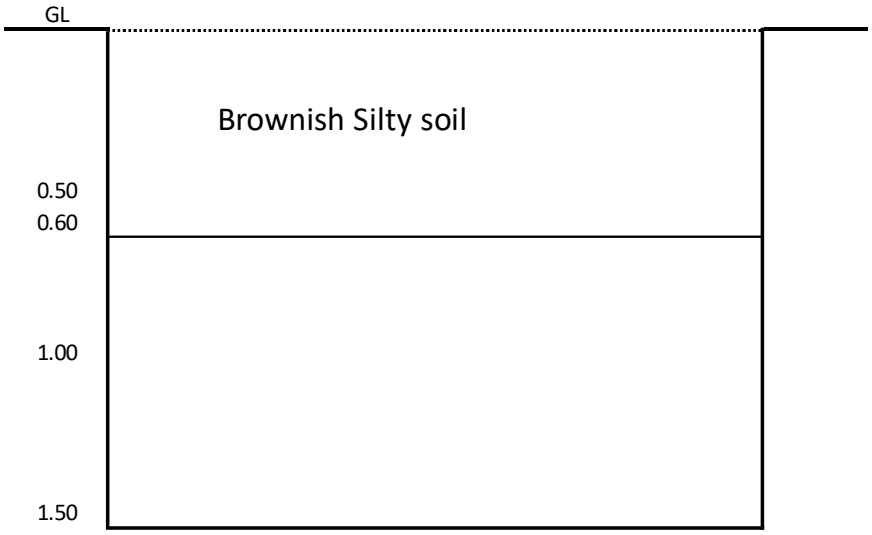
TRIAL PIT LOG NO --12

Trial pit no:	TP-12			Date :	3/6/2016
Location	N = -280		E = 432	Depth. m:	0.6
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		82.737



Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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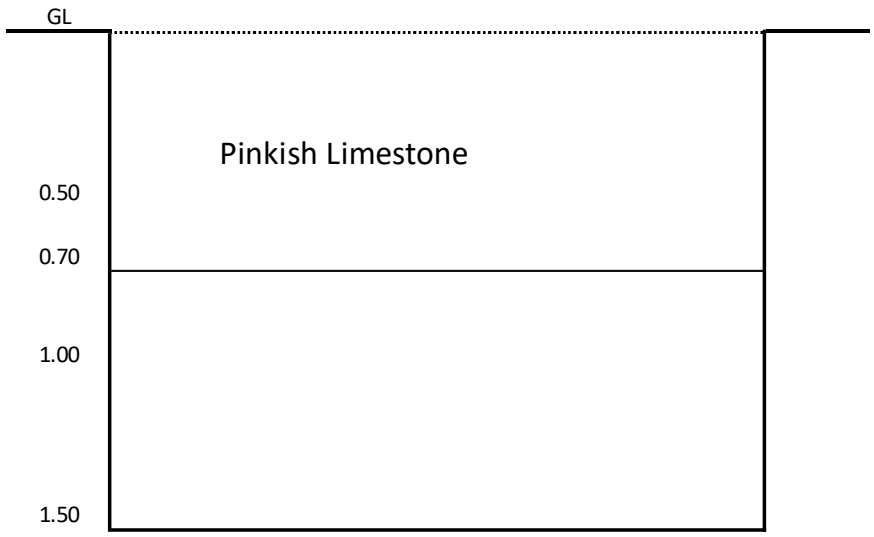
TRIAL PIT LOG NO --13

Trial pit no:	TP-13			Date :	3/6/2016
Location	N = -280		E = 585	Depth, m:	0.7
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		85.198



Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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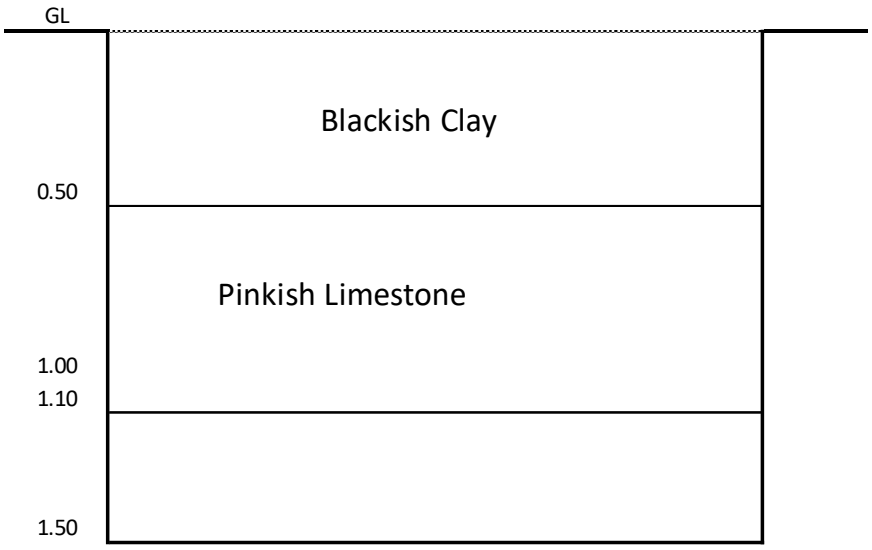
TRIAL PIT LOG NO --14

Trial pit no:	TP-14			Date :	3/6/2016
Location	N = -313		E = -361	Depth, m:	0.8
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		80.213

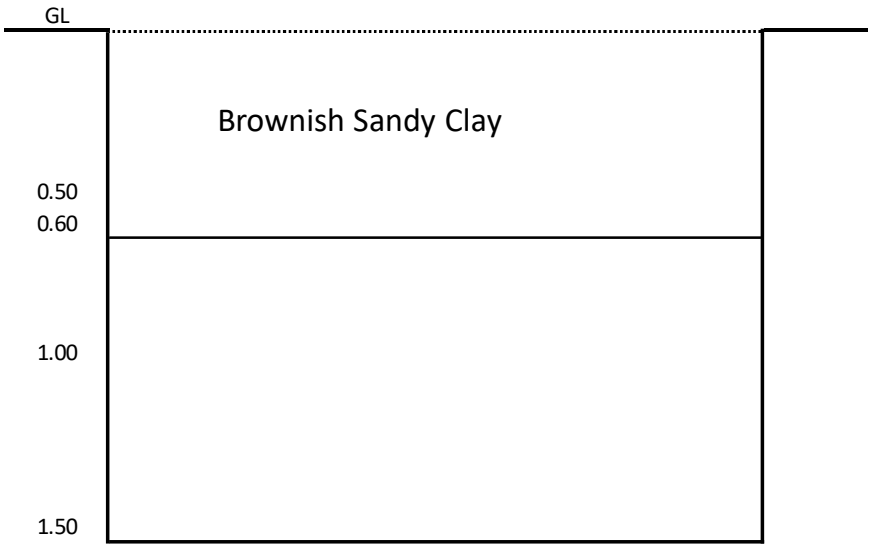
TRIAL PIT LOG NO ---15

Trial pit no:	TP-15			Date :	3/6/2016
Location	N = -404		E = 899	Depth. m:	1.1
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		84.445

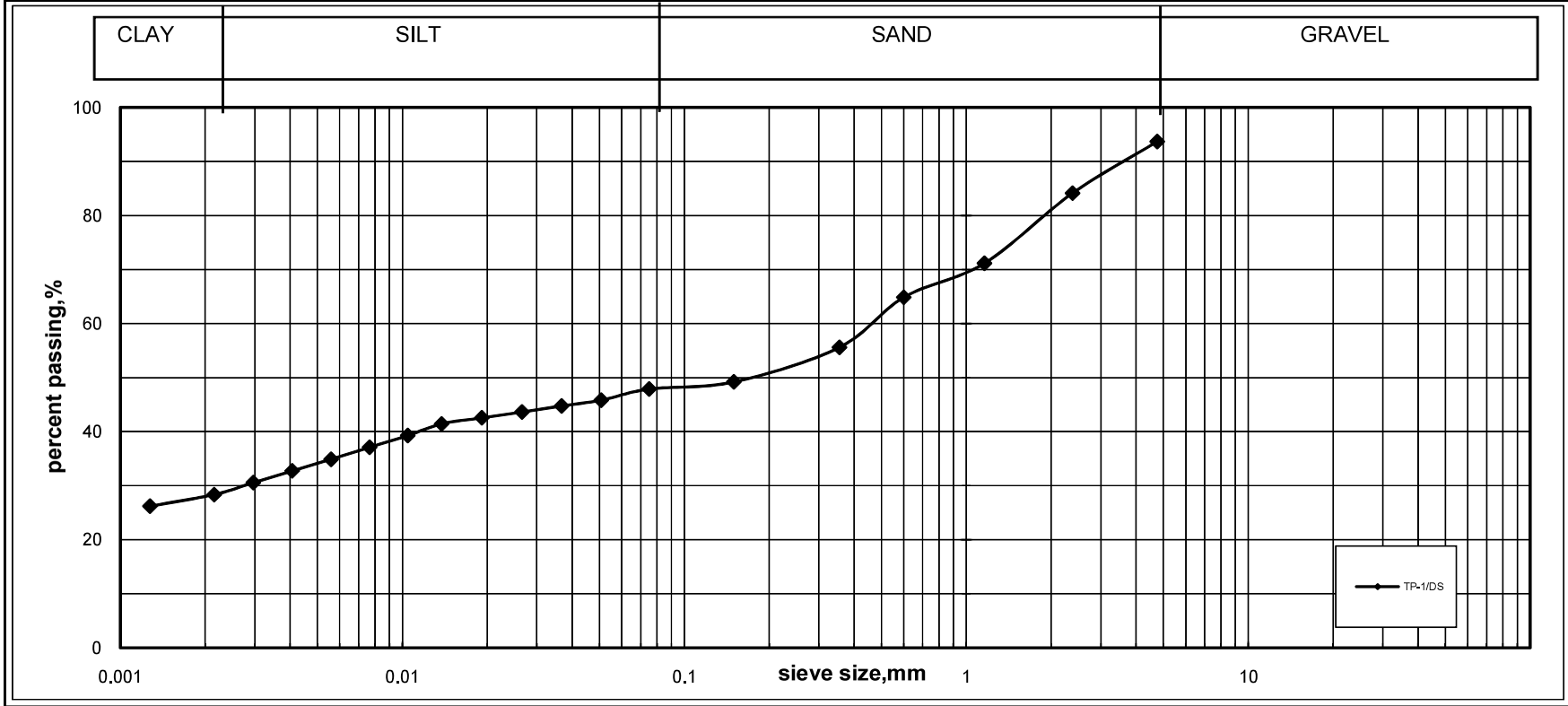


TRIAL PIT LOG NO ---16

Trial pit no:	TP-16			Date :	3/6/2016
Location	N = 926		E = 194	Depth, m:	0.6
Water table, m:	nil	below GL	EGL (EXISTING GROUND LEVEL)R.L.(+)(m)		84.402

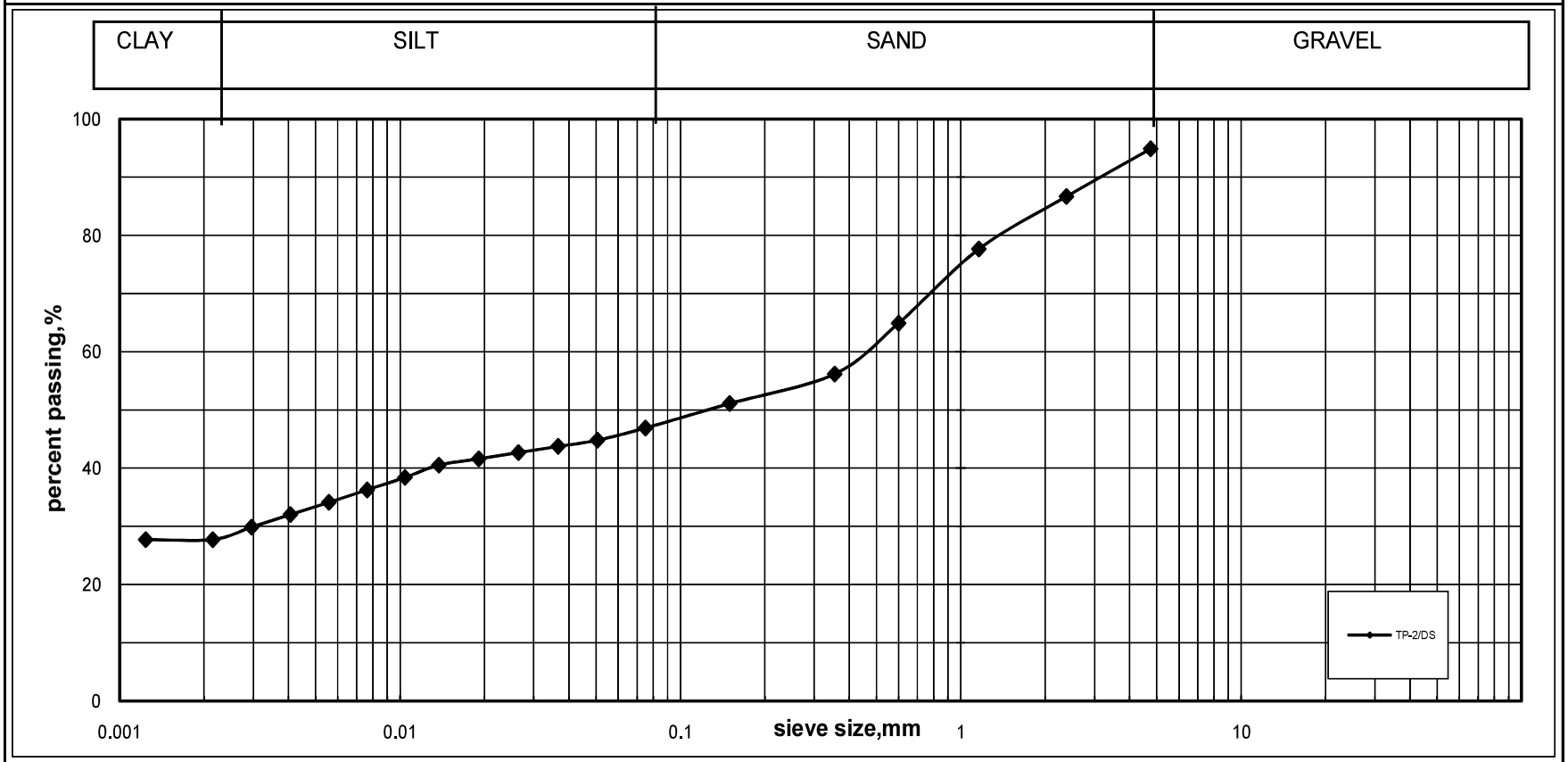


GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-1/DS	0.50	6.28	45.87	19.50	28.36	49.85	22.73	15.67	27.12	2.68	-	-

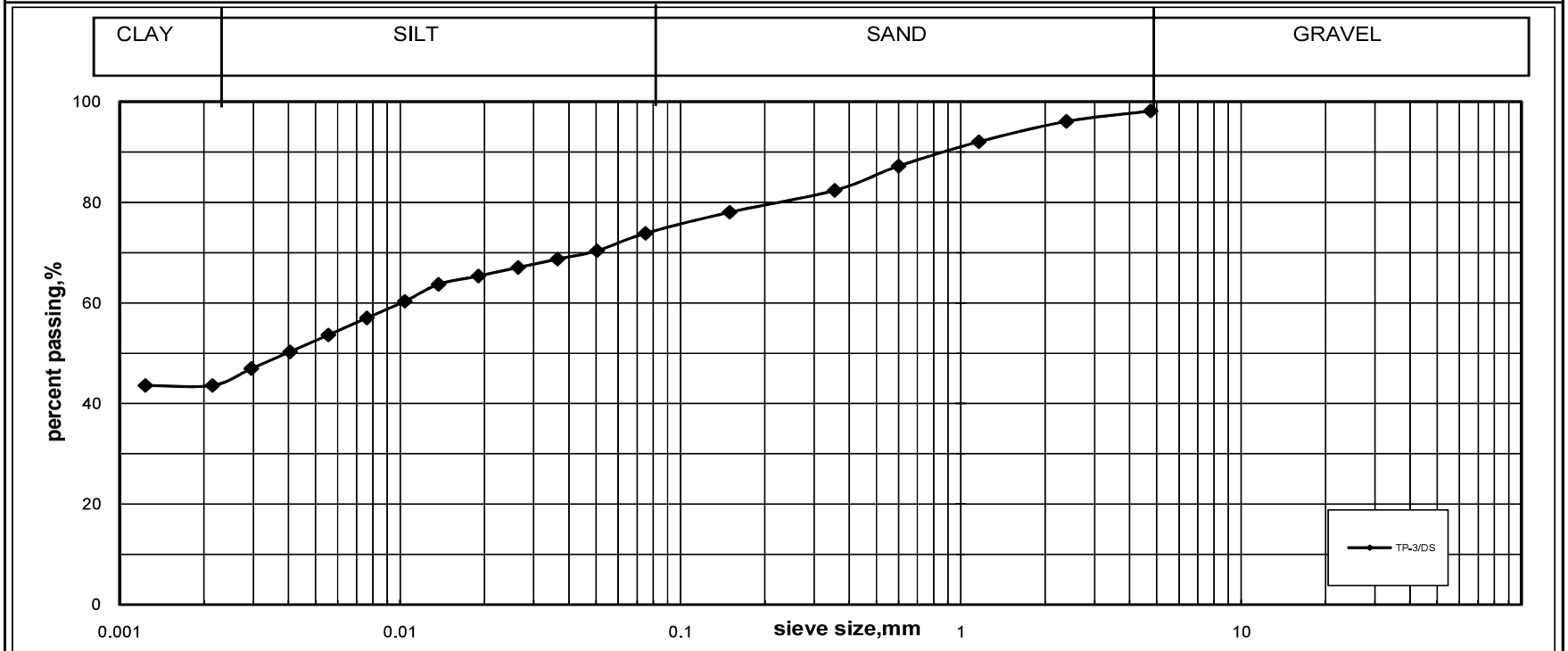
GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-2/DS	0.50	5.11	48.02	19.16	27.71	50.01	23.67	16.01	26.34	2.69	-	-

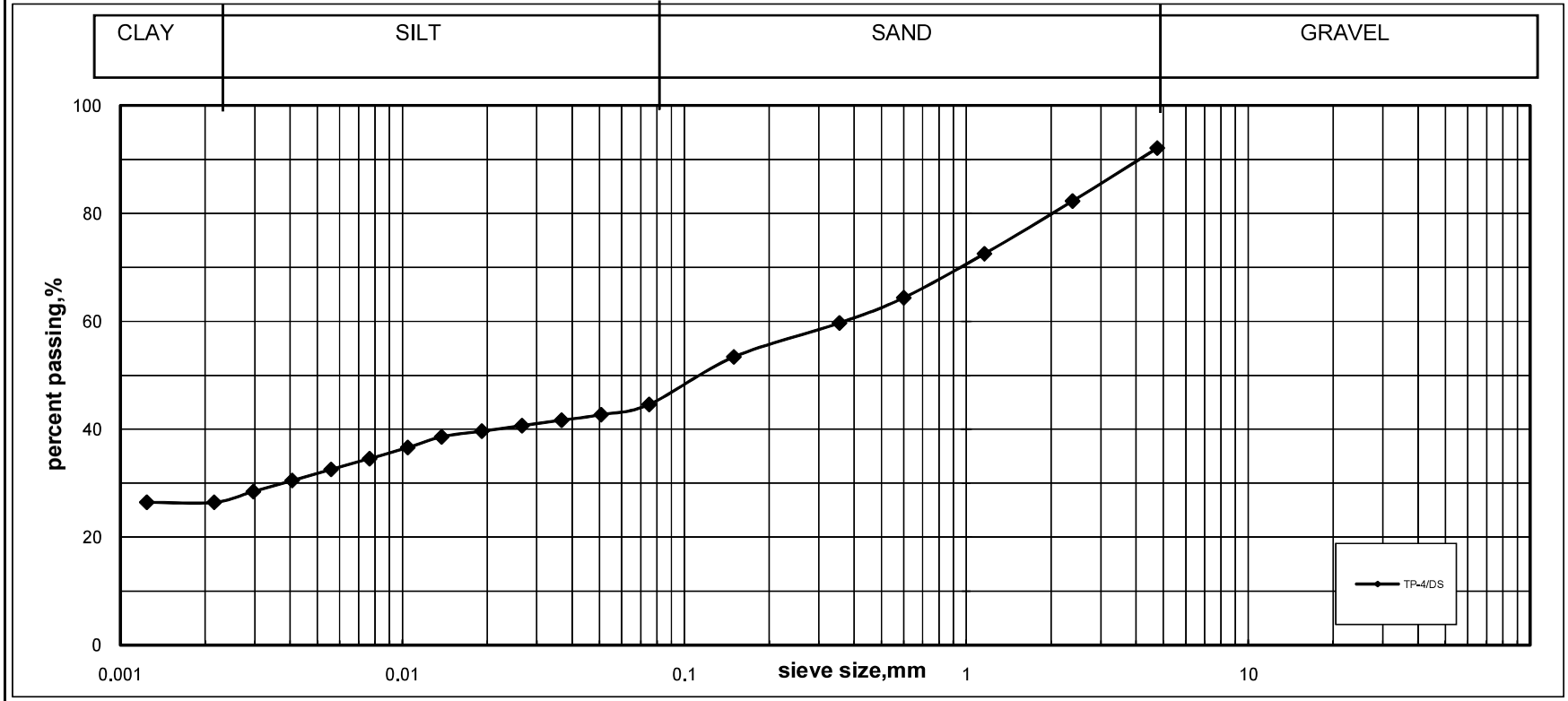
Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Noble Geo-Structs Project No. S 16022
June 7, 2016

GRAIN SIZE ANALYSIS



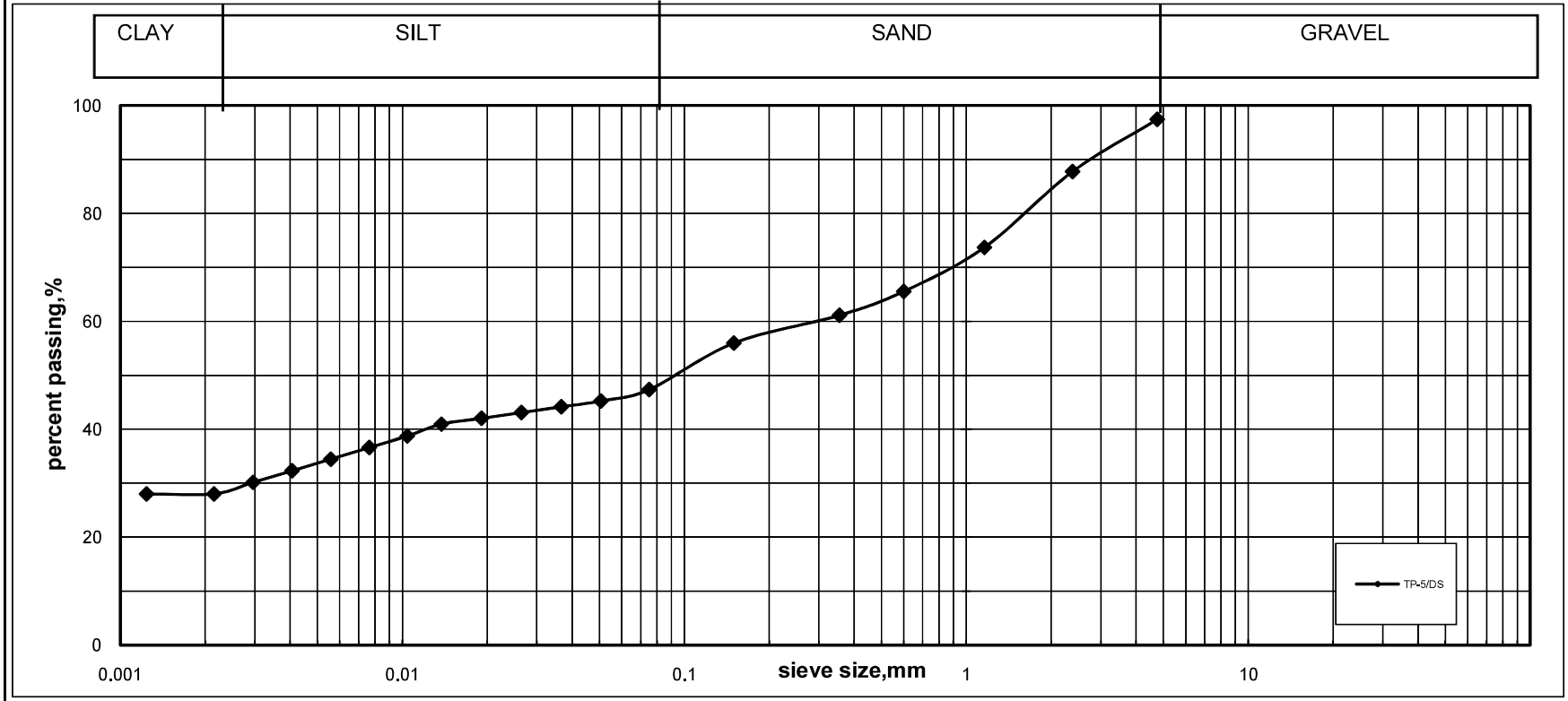
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-3/DS	0.50	1.78	24.36	30.29	43.57	56.68	28.99	13.22	27.69	2.70	-	-

GRAIN SIZE ANALYSIS



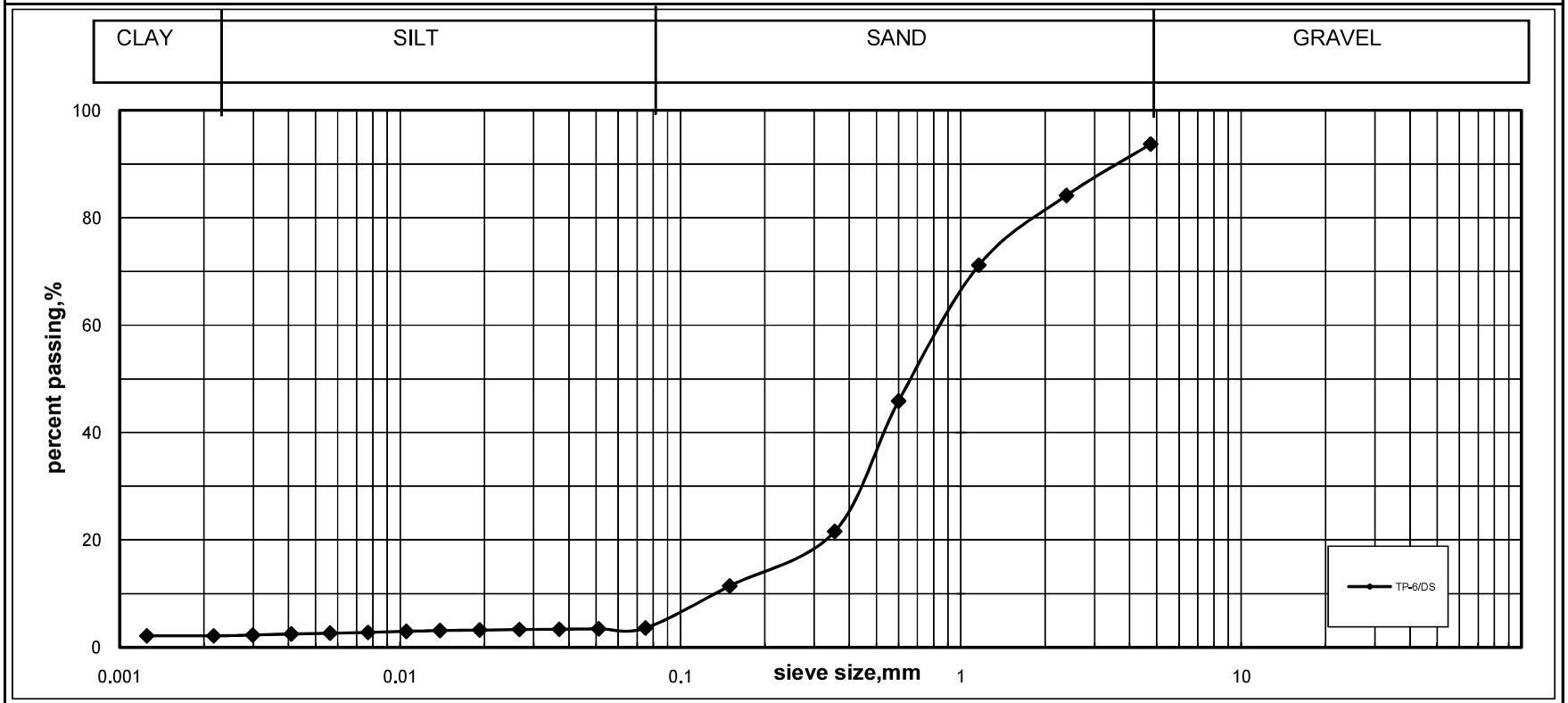
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-4/DS	0.50	7.93	47.49	18.17	26.42	47.50	24.16	16.02	23.34	2.68	-	-

GRAIN SIZE ANALYSIS



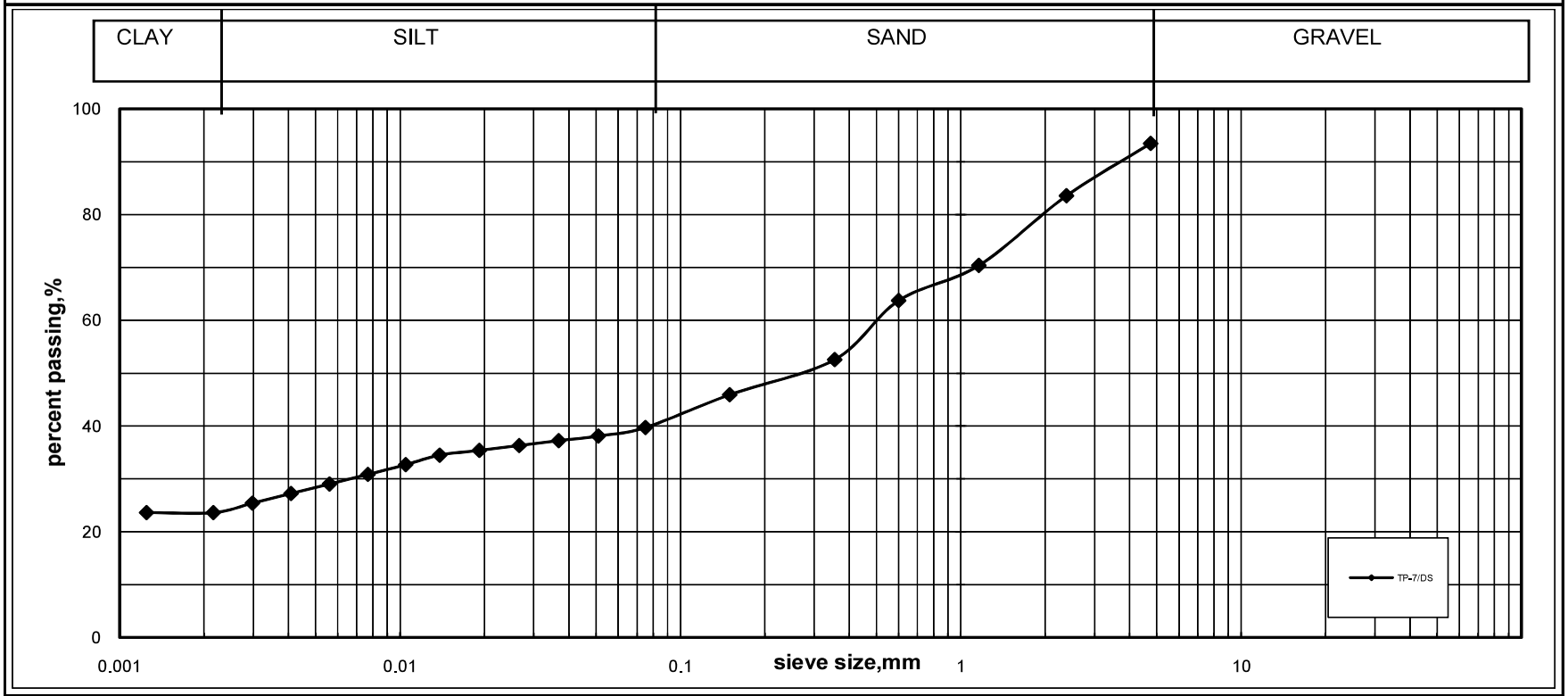
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-5/DS	0.50	2.61	50.05	19.36	27.99	51.37	24.11	15.02	27.26	2.69	-	-

GRAIN SIZE ANALYSIS



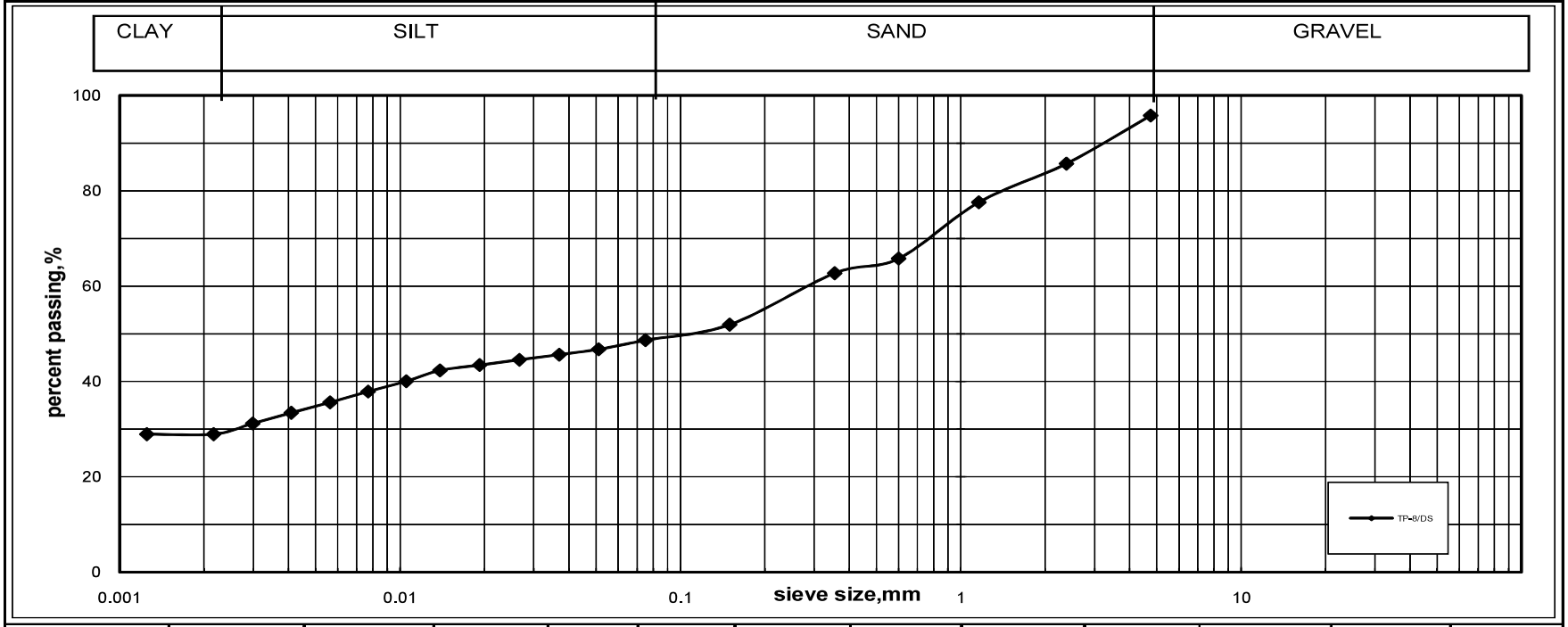
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-6/DS	0.50	6.28	90.15	1.45	2.13	NP	NP	NP	NP	2.66	-	-

GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-7/DS	0.30	6.55	53.73	16.13	23.59	48.77	26.79	14.99	21.98	2.67	-	-

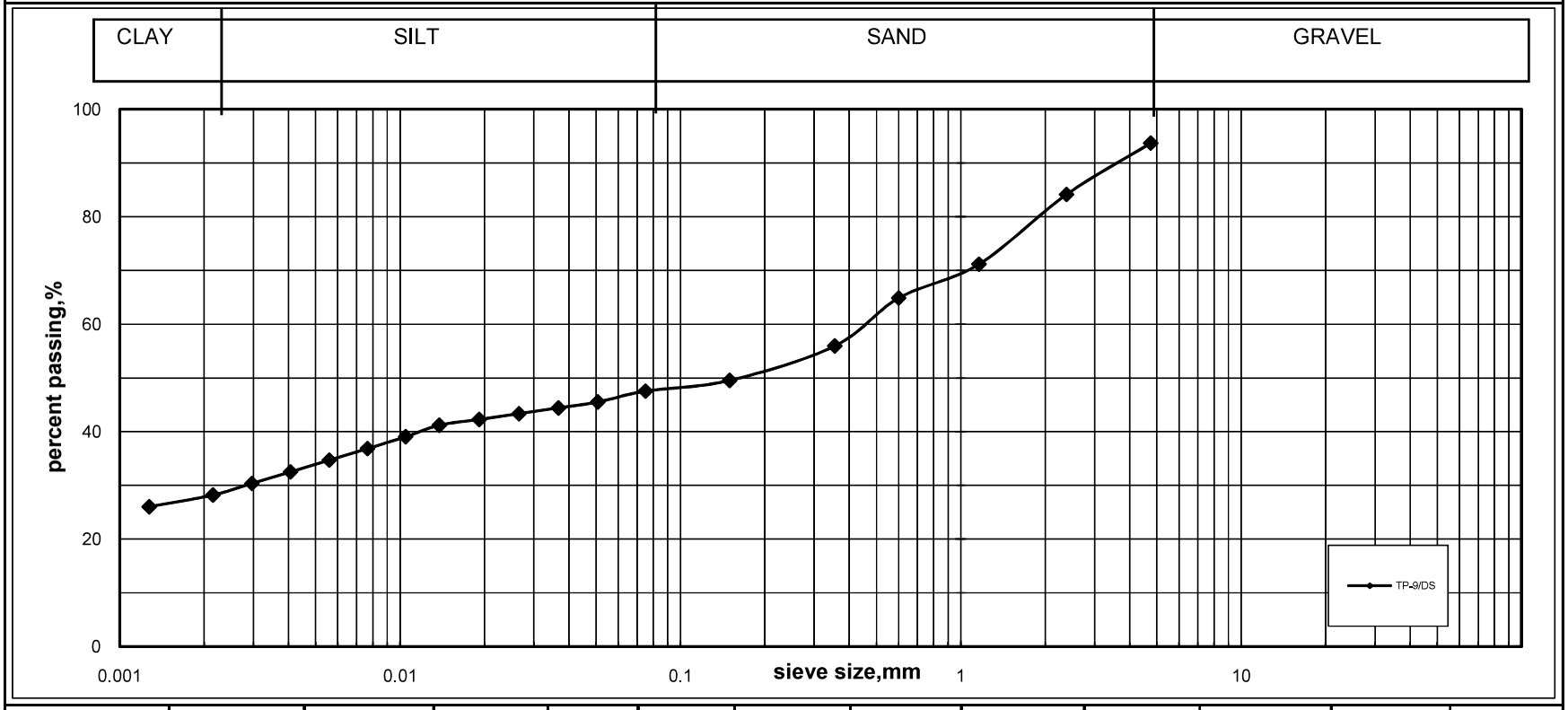
GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-8/DS	0.50	4.21	47.17	19.69	28.94	48.81	25.85	16.32	22.96	2.66	-	-

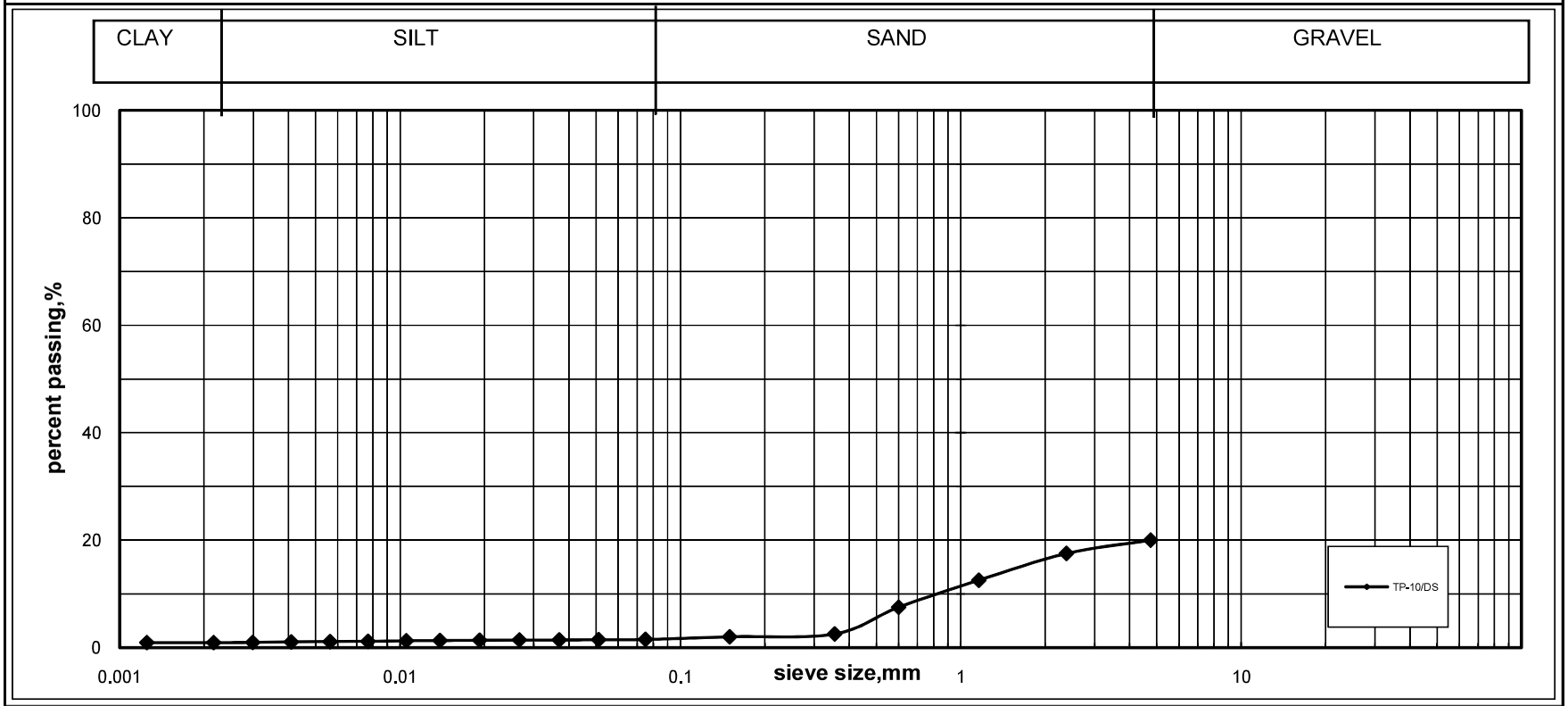
Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Noble Geo-Structs Project No. S 16022
June 7, 2016

GRAIN SIZE ANALYSIS



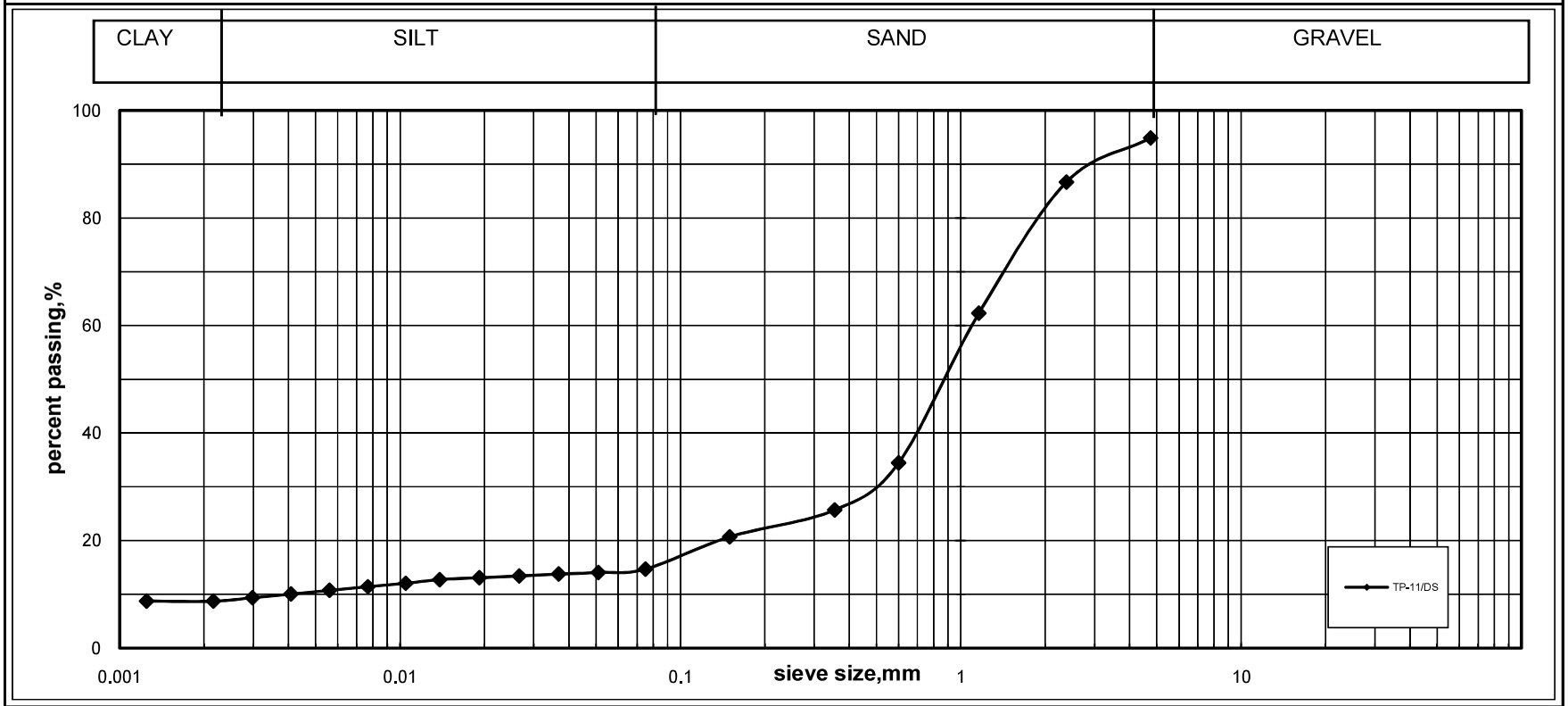
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-9/DS	0.20	6.28	46.18	19.37	28.17	47.12	25.33	15.99	21.79	2.68	-	-

GRAIN SIZE ANALYSIS



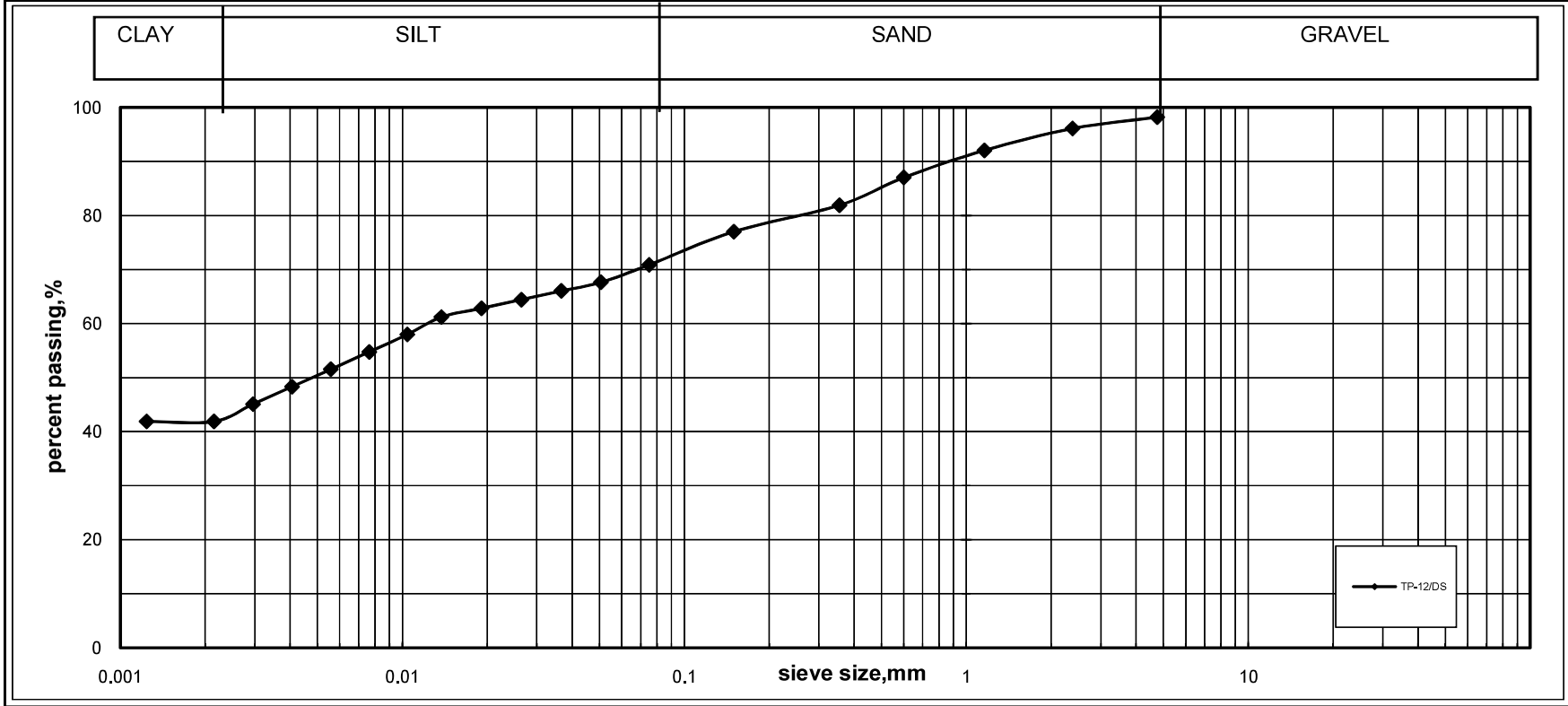
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-10/DS	0.50	80.00	18.50	0.61	0.89	NP	NP	NP	NP	2.66	-	-

GRAIN SIZE ANALYSIS



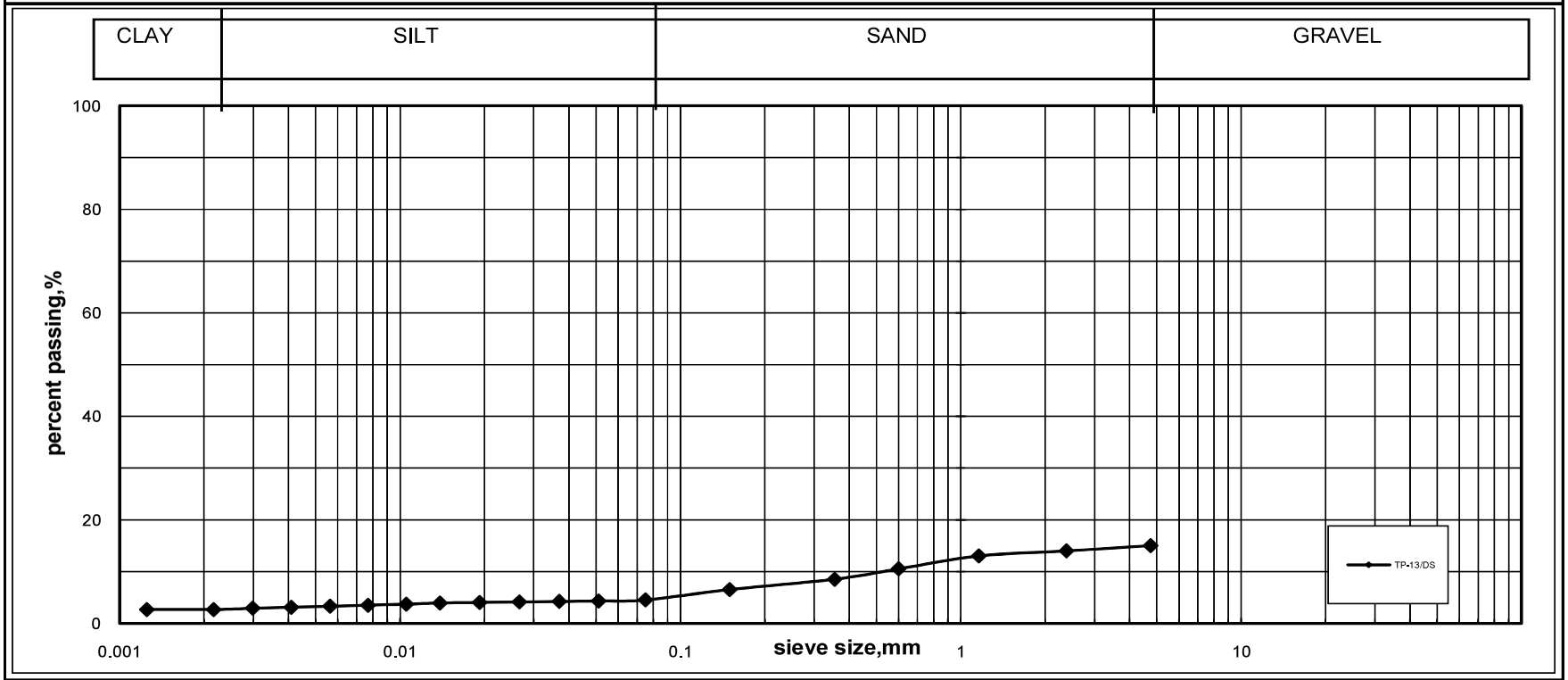
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-11/DS	0.35	5.11	80.24	5.95	8.70	NP	NP	NP	NP	2.67	-	-

GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-12/DS	0.60	1.78	27.38	28.96	41.88	51.90	27.74	14.99	24.16	2.69	-	-

GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-13/DS	0.70	85.00	10.50	1.82	2.68	NP	NP	NP	NP	2.66	-	-

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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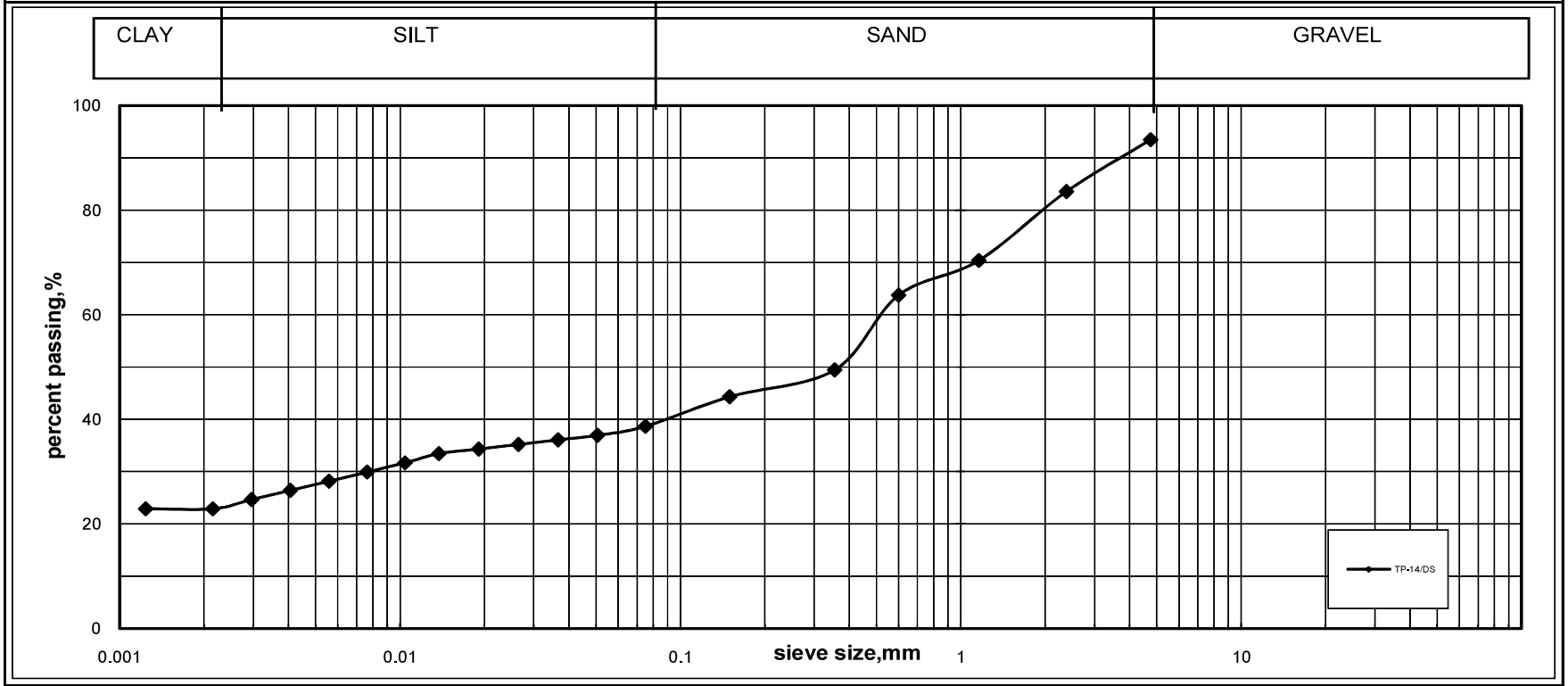
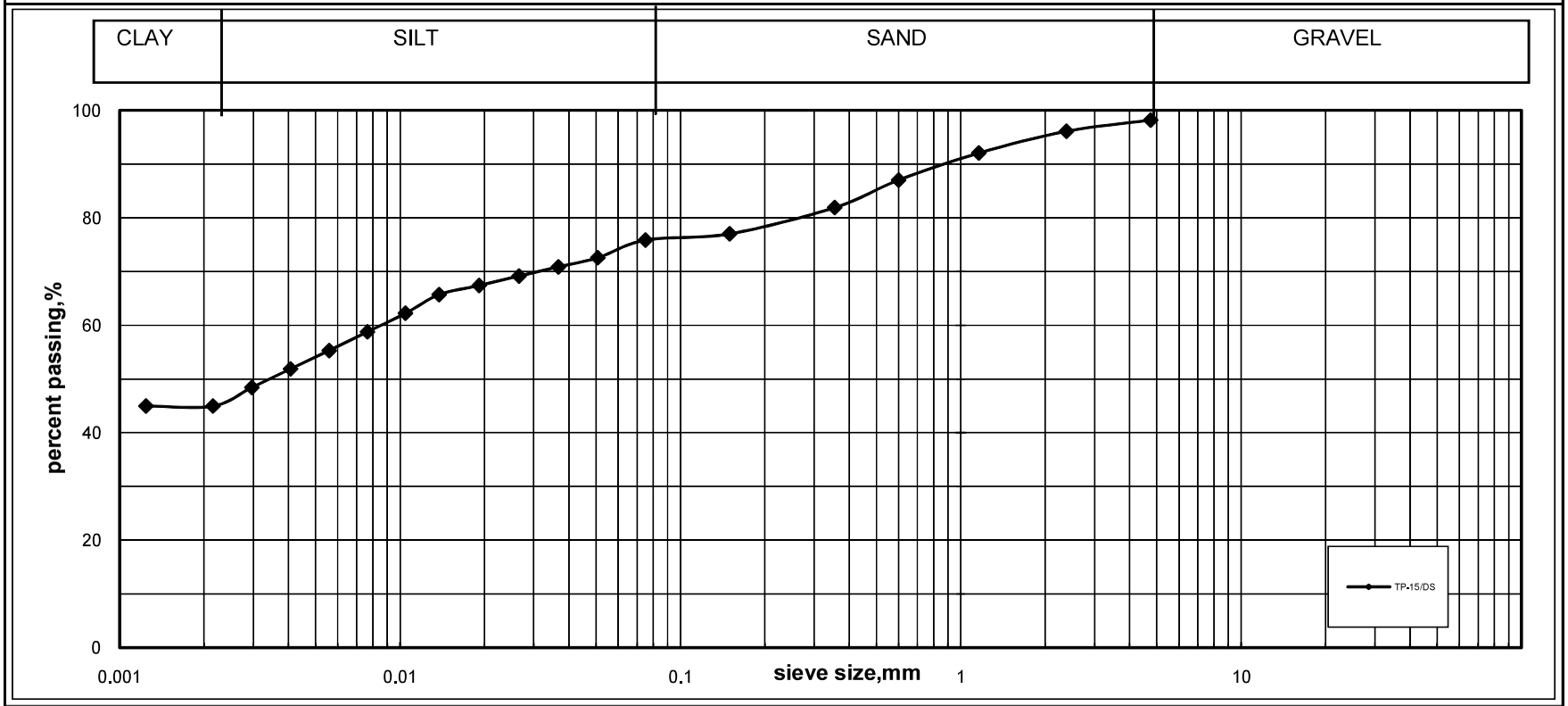
June 7, 2016

GRAIN SIZE ANALYSIS



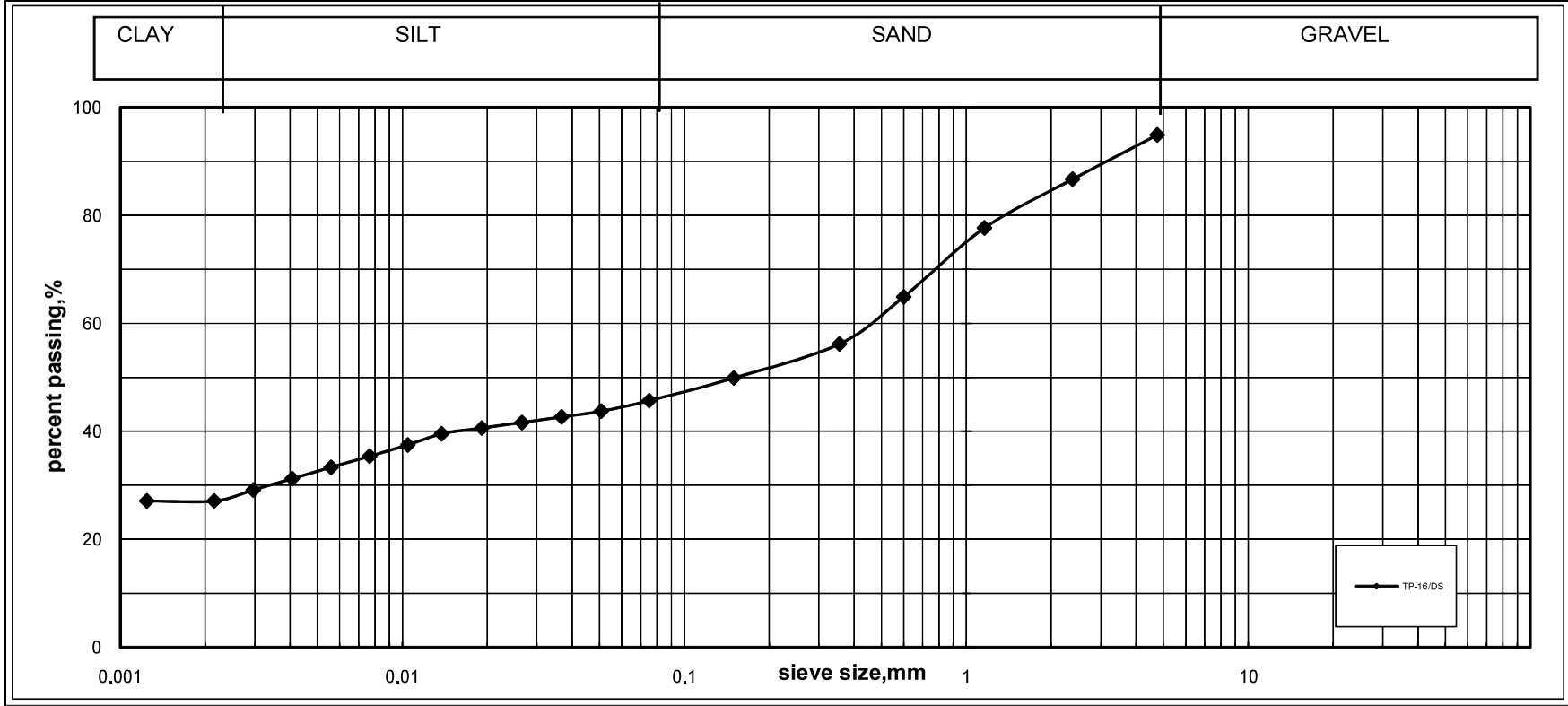
BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-14/DS	0.50	6.55	54.80	15.80	22.85	49.41	NP	16.87	49.41	2.69	-	-

GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-15/DS	0.50	1.78	22.38	30.90	44.94	56.68	28.99	14.26	27.69	2.68	-	-

GRAIN SIZE ANALYSIS



BH. No.	Depth, m	Gravels %	Sand %	Silt %	Clay %	L.L.%	P.L. %	S.L. %	P.I. %	Sp.Gravity	NMC %	DD g/cc
TP-16/DS	0.50	5.11	49.24	18.61	27.05	45.72	25.88	16.08	19.84	2.68	-	-

Summary results

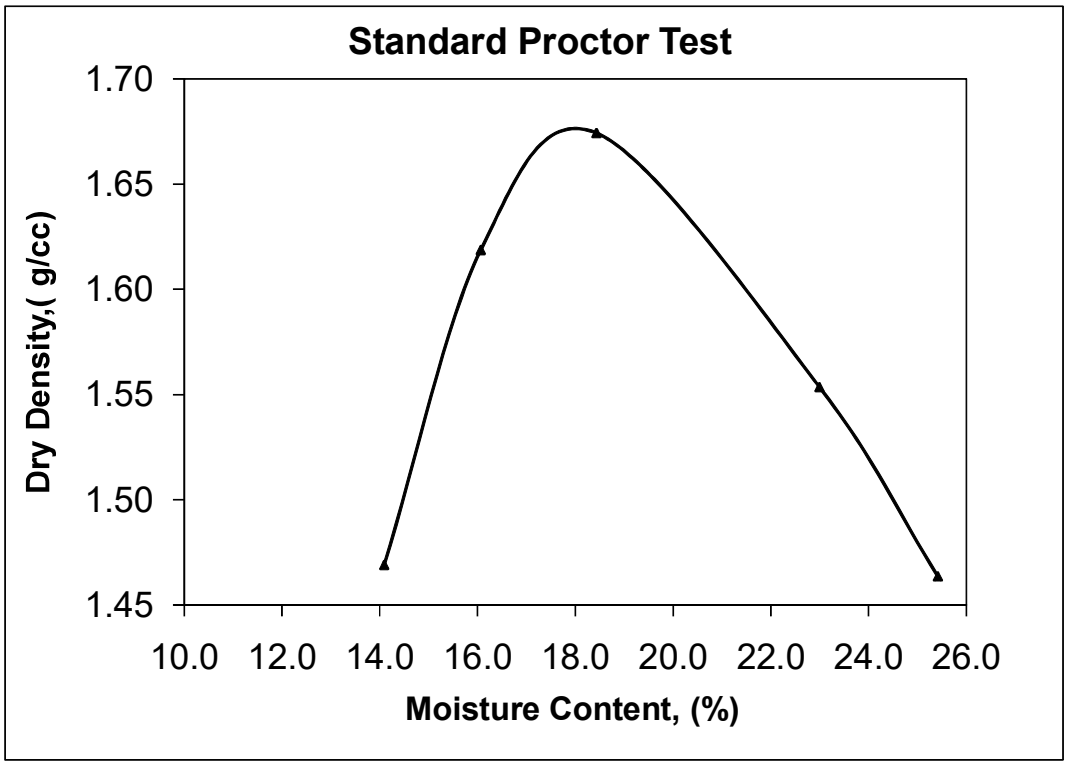
SR. No.	Trial Pit No	Depth (m)	Specific Gravity	Field			Swelling	free swell Index(%)	Relative Density (%)
				Moisture Content(%)	Bulk Density(g/cc)	Dry Density(g/cc)	kg/cm^2		
1	TP-1	0.50	2.68	7.36	1.85	1.72	Nil	25	-
2	TP-2	0.50	2.69	7.52	1.88	1.75	Nil	25	-
3	TP-3	0.50	2.70	7.87	1.79	1.66	Nil	30	-
4	TP-4	0.50	2.68	8.74	1.85	1.70	Nil	20	-
5	TP-5	0.50	2.69	9.74	1.82	1.66	Nil	25	-
6	TP-6	0.50	2.66	8.33	1.95	1.80	Nil	10	0.76
7	TP-7	0.30	2.67	9.19	1.83	1.68	Nil	25	-
8	TP-8	0.50	2.66	7.75	1.86	1.73	Nil	20	-
9	TP-9	0.20	2.68	8.07	1.83	1.69	Nil	20	-
10	TP-10	0.50	2.66	4.84	1.95	1.86	Nil	10	0.60
11	TP-11	0.35	2.67	5.72	1.93	1.83	Nil	10	0.76
12	TP-12	0.60	2.69	10.68	1.8	1.63	Nil	35	-
13	TP-13	0.70	2.66	7.55	1.97	1.83	Nil	10	0.60
14	TP-14	0.50	2.69	8.37	1.84	1.70	Nil	15	-
15	TP-15	0.50	2.68	6.53	1.78	1.67	Nil	30	-
16	TP-16	0.50	2.68	7.58	1.84	1.71	Nil	15	-

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Noble Geo-Structs Project No. S 16022
June 7, 2016

STANDARD PROCTOR TEST

Pit No. : **TP-1** **Co-Ordinates : N = 851 E = 194**

Sample ID. DS DEPTH = 0.5 m



Optimum Moisture Content, %	18.43
Maximum Dry Density, g/cc	1.67

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Noble Geo-Structs Project No. S 16022
June 7, 2016

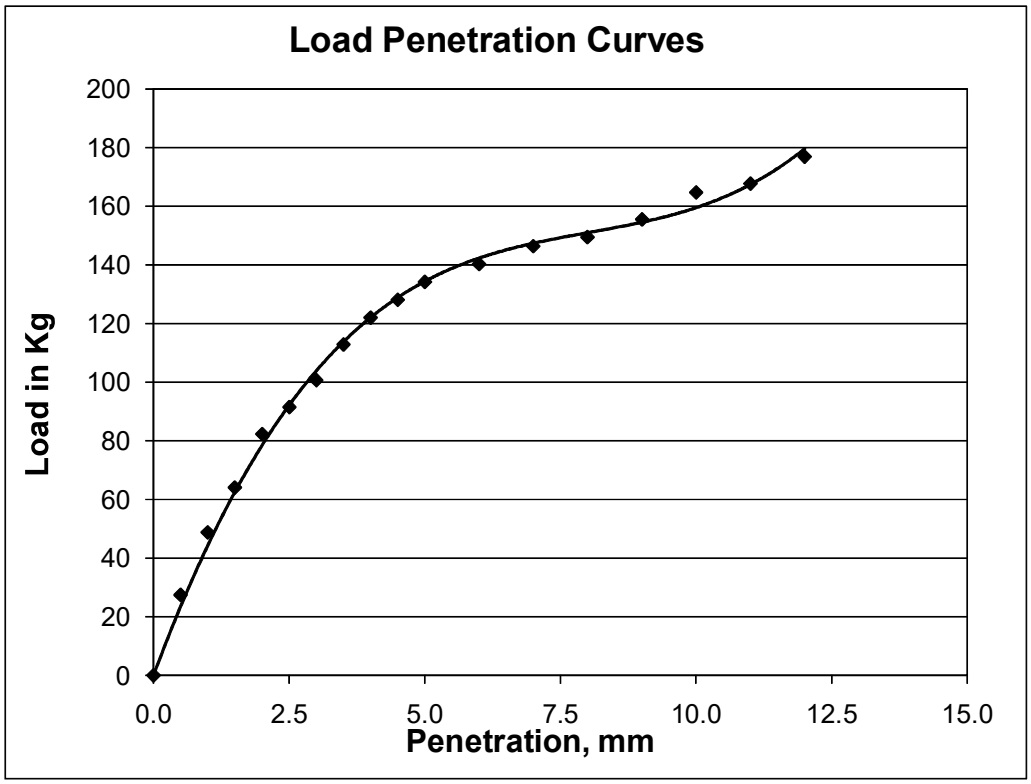
LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. : TP-1 **Co-Ordinates : N = 851 E = 194**

Sample ID. DS DEPTH = 0.5 m

OMC : % 18.43 **MDD , g/cc :** 1.67

Proving Ring constant: 3.05

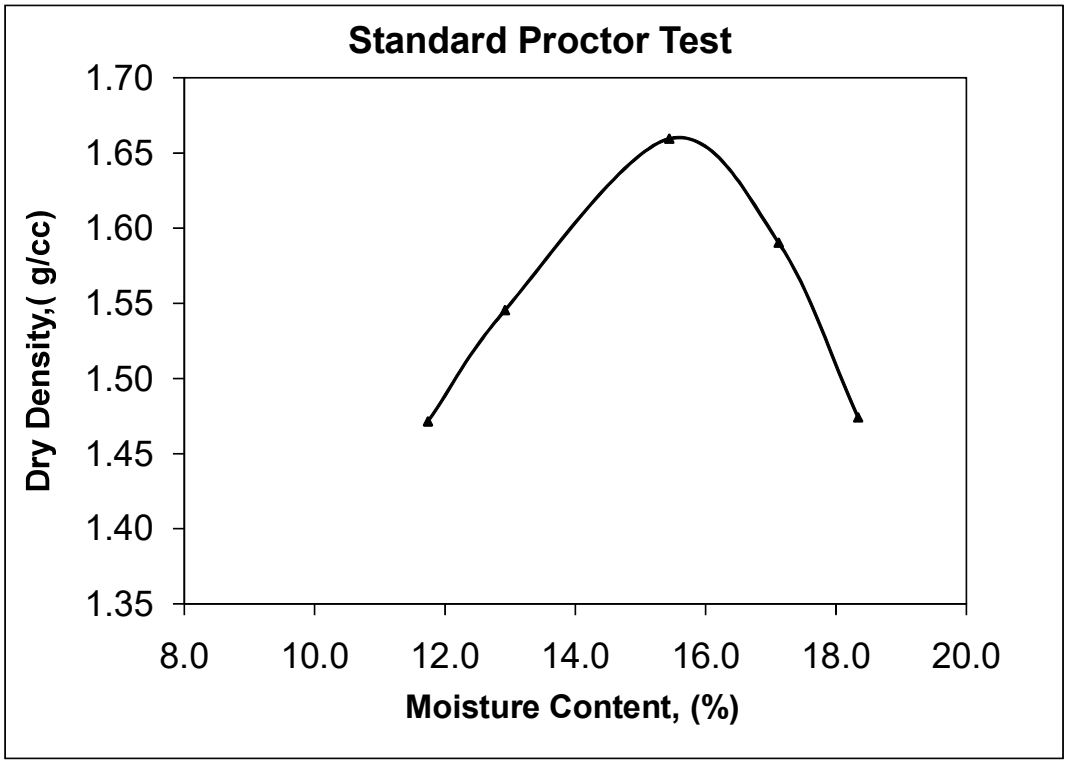


Test Results :

LOAD AT 2.5MM PENETRATION	91.5
LOAD AT 5 MM PENETRATION	134.2
C.B.R AT 2.5MM PENETRATION	**6.68**
C.B.R. AT 5 MM PENETRATION	**6.53**

STANDARD PROCTOR TEST

Pit No. :	**TP-2**	**Co-Ordinates : N = 357**	**E = 445**
Sample ID.	DS	DEPTH =	0.5 m



Optimum Moisture Content, %	15.44
Maximum Dry Density, g/cc	1.66

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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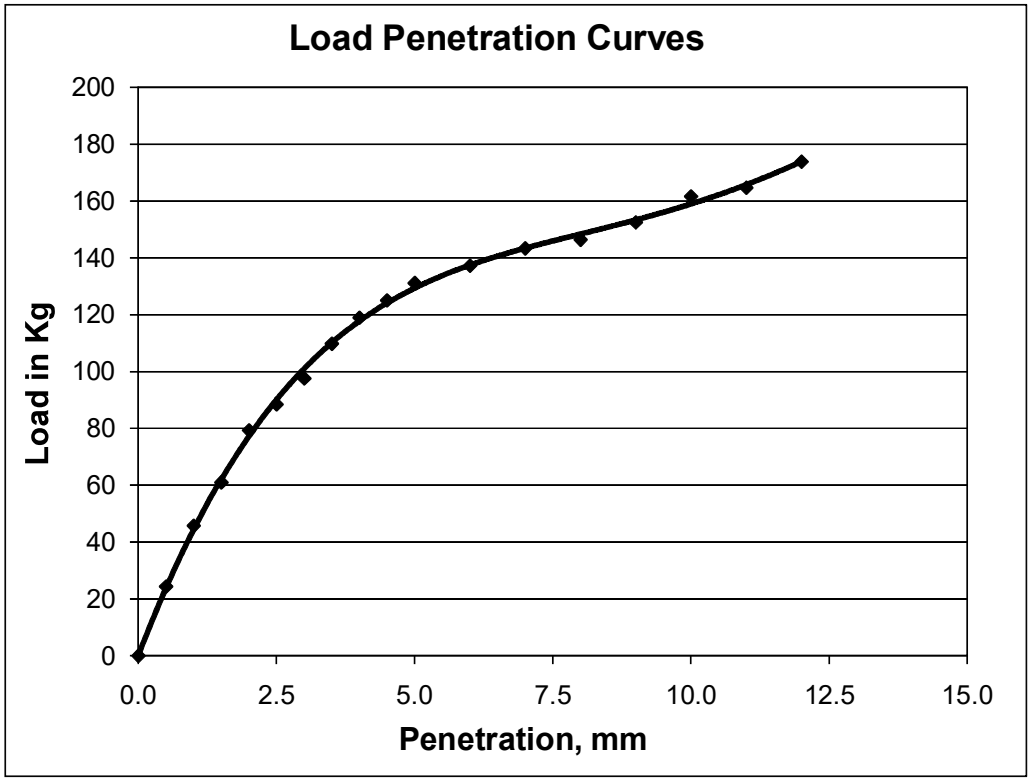
Pit No. :	**Tp-2**	**Co-Ordinates : N = 357**	**E = 445**
Sample ID.	DS	DEPTH =	0.5 m
OMC : %	15.44	**MDD , g/cc :**	1.66
		Proving Ring constant:	3.05

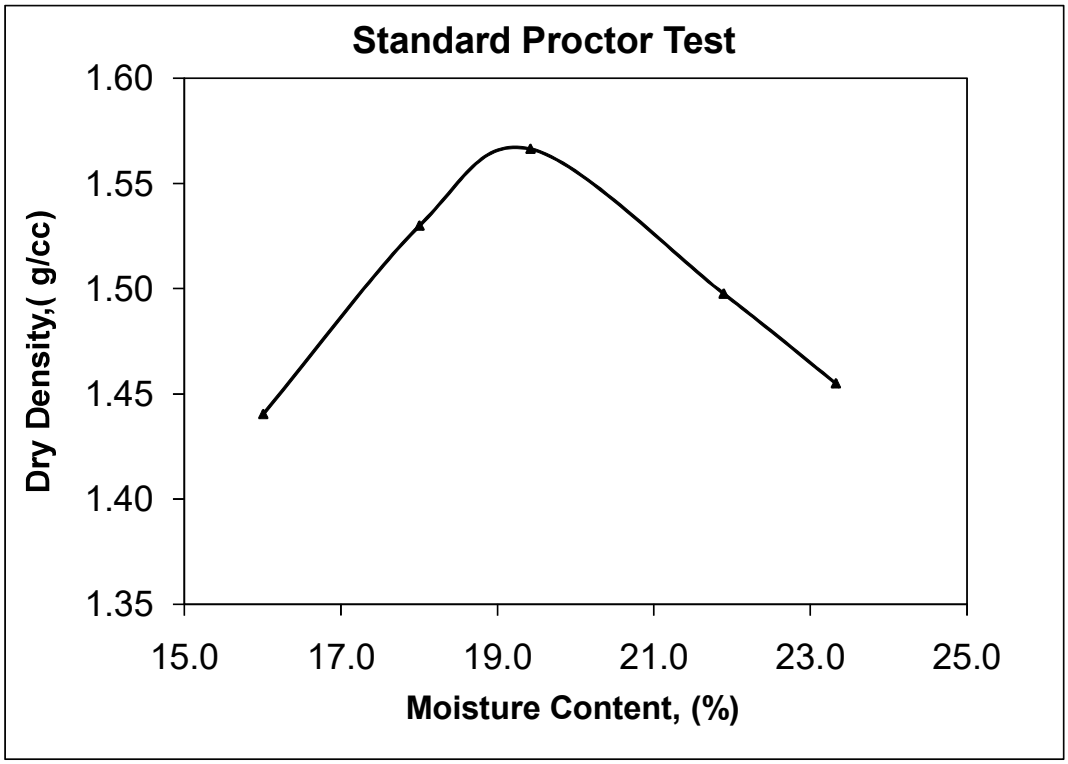


Test Results :

LOAD AT 2.5MM PENETRATION	88.5
LOAD AT 5 MM PENETRATION	131.2
C.B.R AT 2.5MM PENETRATION	**6.46**
C.B.R. AT 5 MM PENETRATION	**6.38**

STANDARD PROCTOR TEST

Pit No. :	**TP-3**	**Co-Ordinates : N = -64**	**E = -29**
Sample ID.	DS	DEPTH =	0.5 m



Optimum Moisture Content, %	19.42
Maximum Dry Density, g/cc	1.57

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
Noble Geo-Structs Project No. S 16022
June 7, 2016

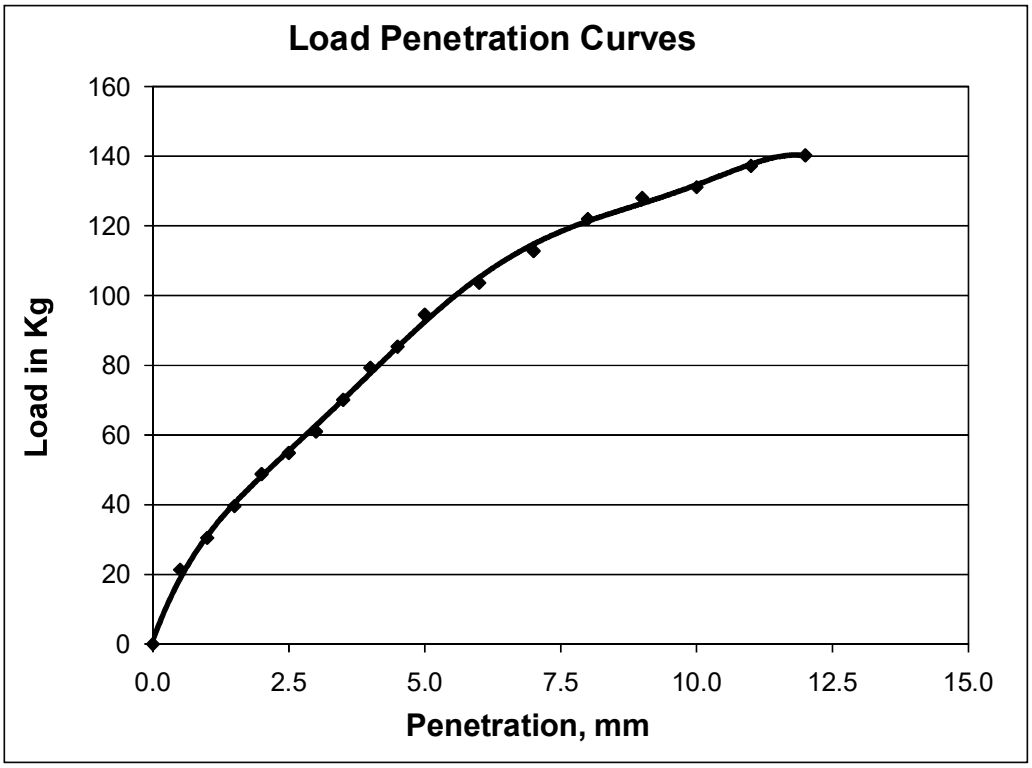
LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. : TP-3 **Co-Ordinates : N = -64 E = -29**

Sample ID. DS DEPTH = 0.5 m

OMC : % 19.42 **MDD , g/cc :** 1.57

Proving Ring constant: 3.05



Test Results :

LOAD AT 2.5MM PENETRATION	54.9
LOAD AT 5 MM PENETRATION	94.6
C.B.R AT 2.5MM PENETRATION	**4.01**
C.B.R. AT 5 MM PENETRATION	**4.60**

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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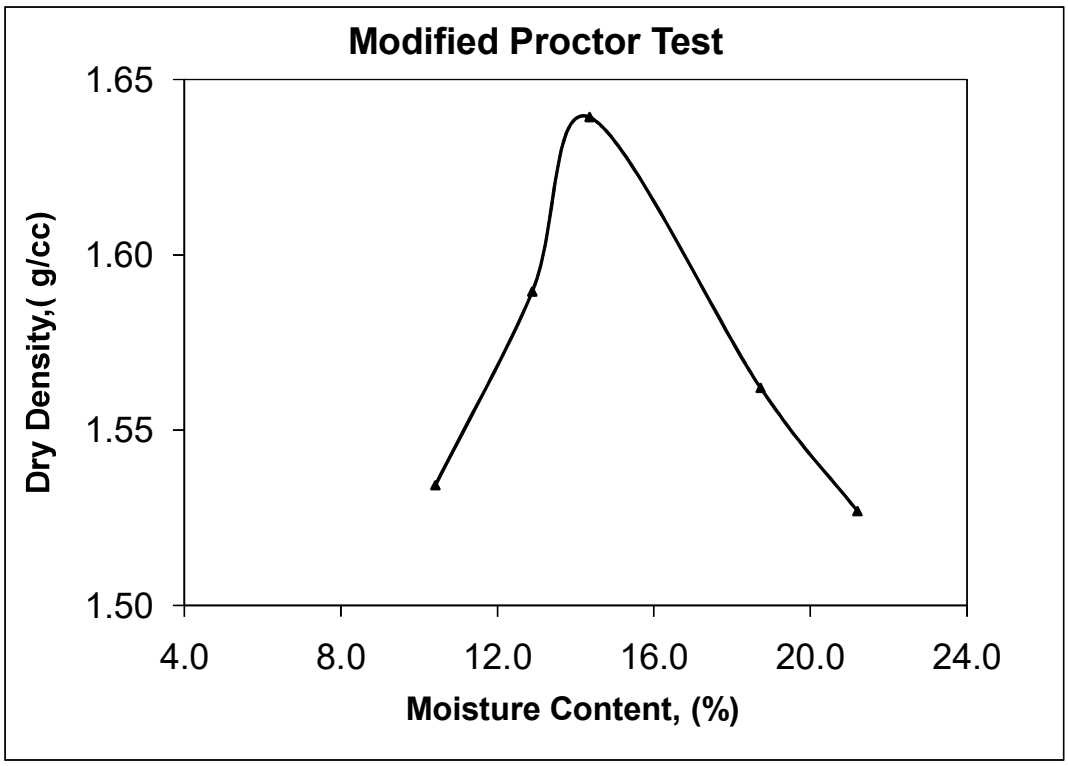
MODIFIED PROCTOR TEST

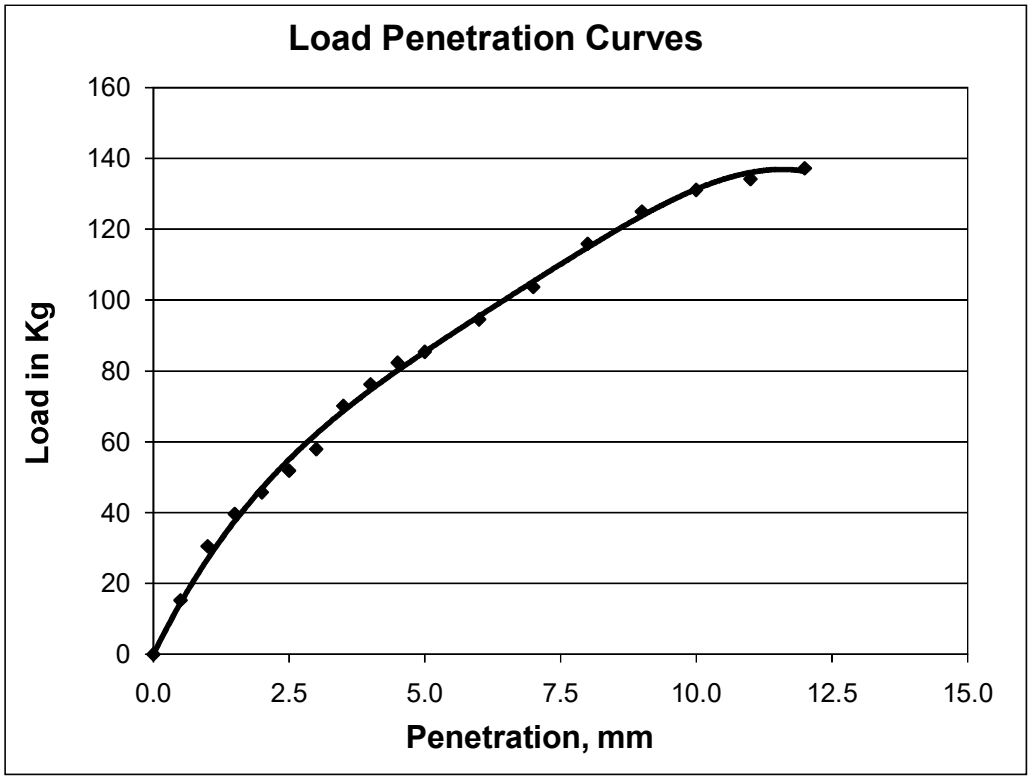
Pit No. :	**TP-4**	**Co-Ordinates : N = -64 E = 99**	
Sample ID.	DS	DEPTH =	0.5 m



Optimum Moisture Content, %	14.35
Maximum Dry Density, g/cc	1.64

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-4**	**Co-Ordinates : N = -64 E = 99**	
Sample ID.	DS	DEPTH =	0.5 m
OMC : %	14.35	**MDD , g/cc :**	1.64
		Proving Ring constant:	3.05



Test Results :

LOAD AT 2.5MM PENETRATION	51.9
LOAD AT 5 MM PENETRATION	85.4
C.B.R AT 2.5MM PENETRATION	**3.78**
C.B.R. AT 5 MM PENETRATION	**4.16**

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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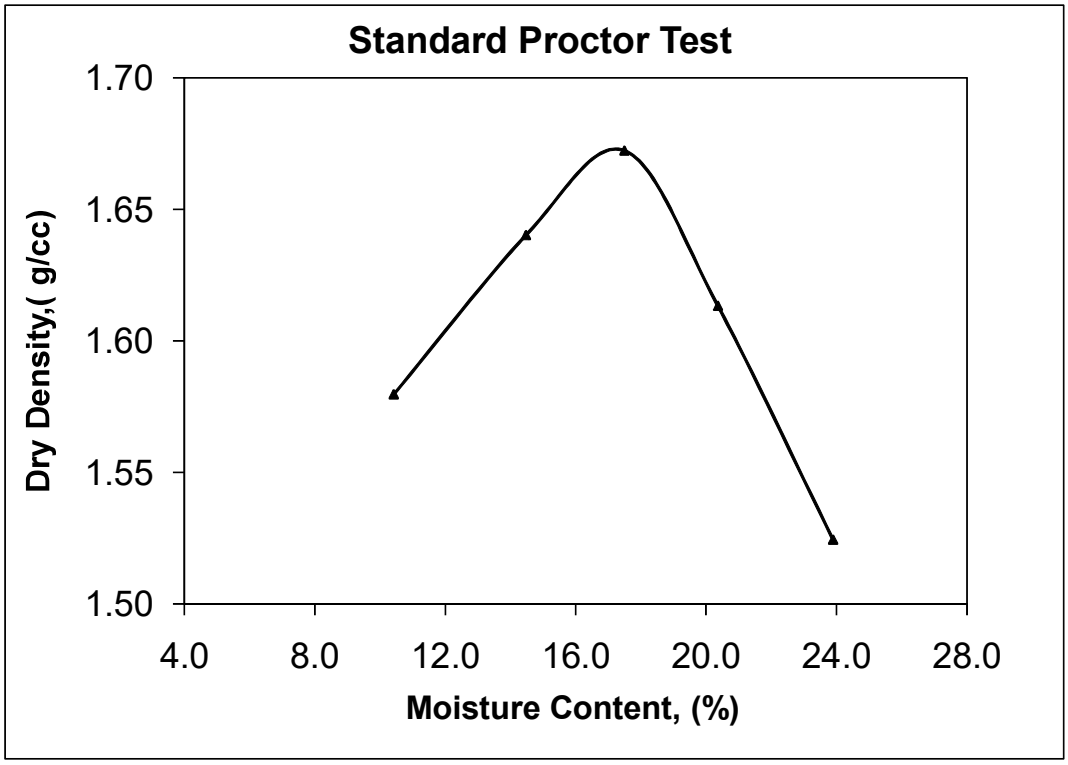
STANDARD PROCTOR TEST

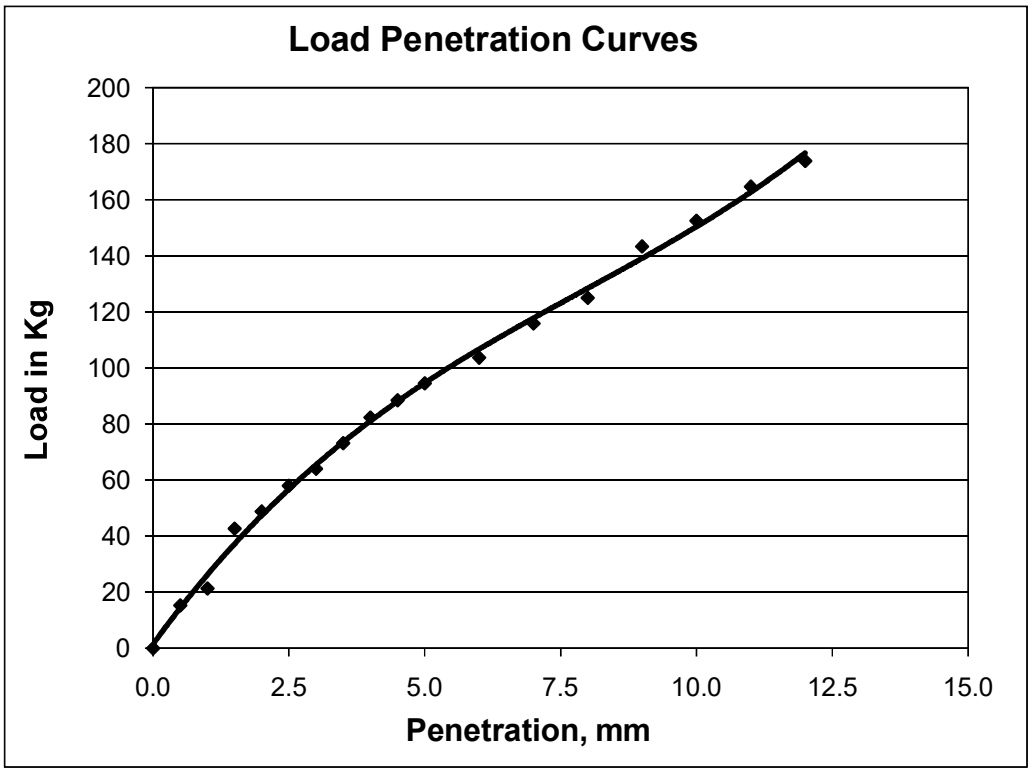
Pit No. :	**TP-5**	**Co-Ordinates : N = -64 E = 396**	
Sample ID.	DS	DEPTH =	0.5 m



Optimum Moisture Content, %	17.49
Maximum Dry Density, g/cc	1.67

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-5**	**Co-Ordinates : N = -64 E = 396**	
Sample ID.	DS	DEPTH =	0.5 m
OMC : %	17.49	**MDD , g/cc :**	1.67
		Proving Ring constant:	3.05



Test Results :

LOAD AT 2.5MM PENETRATION	58.0
LOAD AT 5 MM PENETRATION	94.6
C.B.R AT 2.5MM PENETRATION	**4.23**
C.B.R. AT 5 MM PENETRATION	**4.60**

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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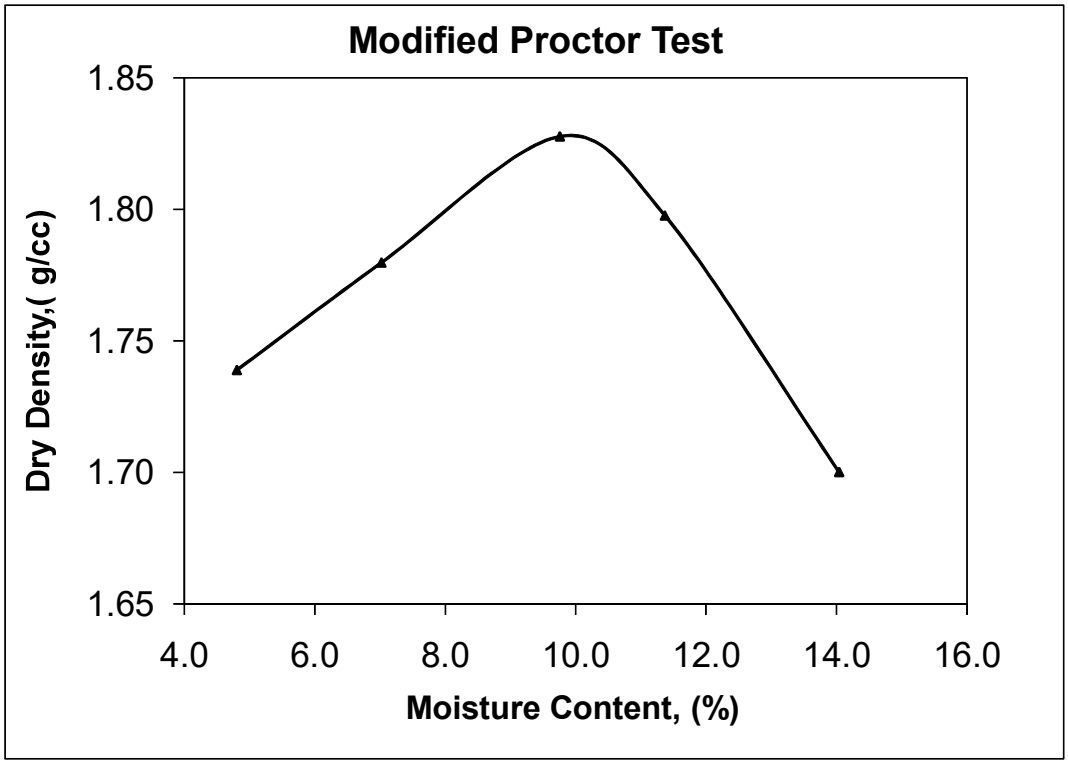
MODIFIED PROCTOR TEST

Pit No. :	**TP-6**	**Co-Ordinates : N = -64 E = 659**	
Sample ID.	DS	DEPTH =	0.5 m



Optimum Moisture Content, %	9.76
Maximum Dry Density, g/cc	1.83

Project :5x800MW Yadadri Thermal Power Station at Veerlapalem, Telangana State.
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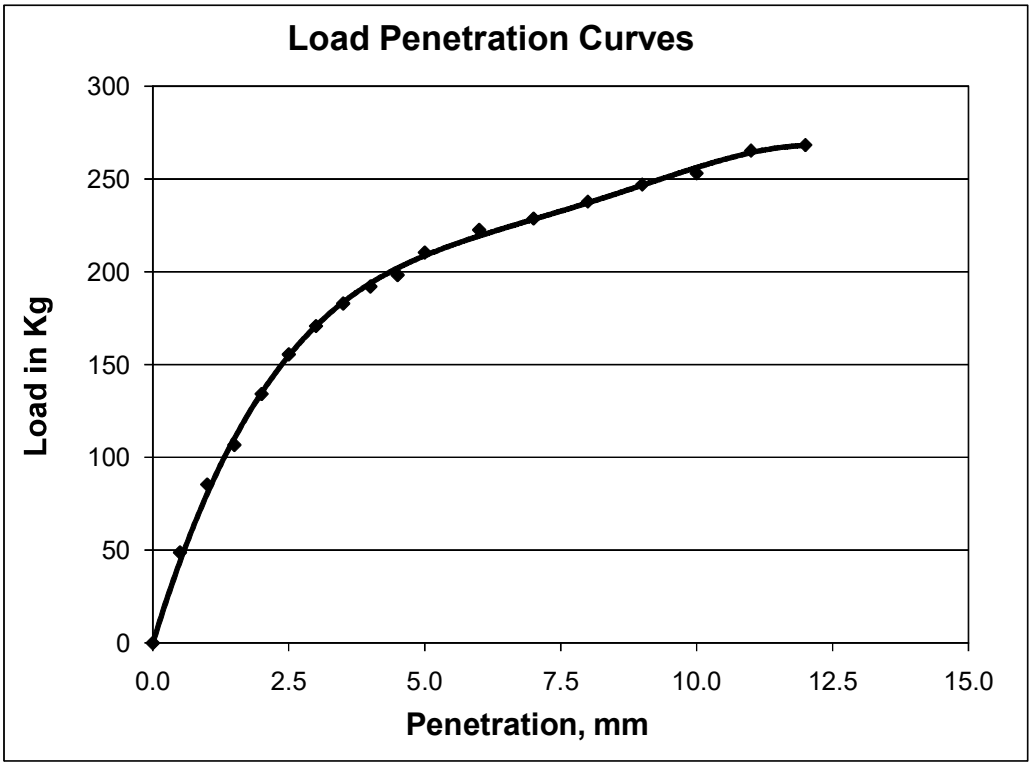
LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-6**	**Co-Ordinates : N = -64 E = 659**	
Sample ID.	DS	DEPTH =	0.5 m
OMC : %	9.76	**MDD , g/cc :**	1.83
		Proving Ring constant:	3.05



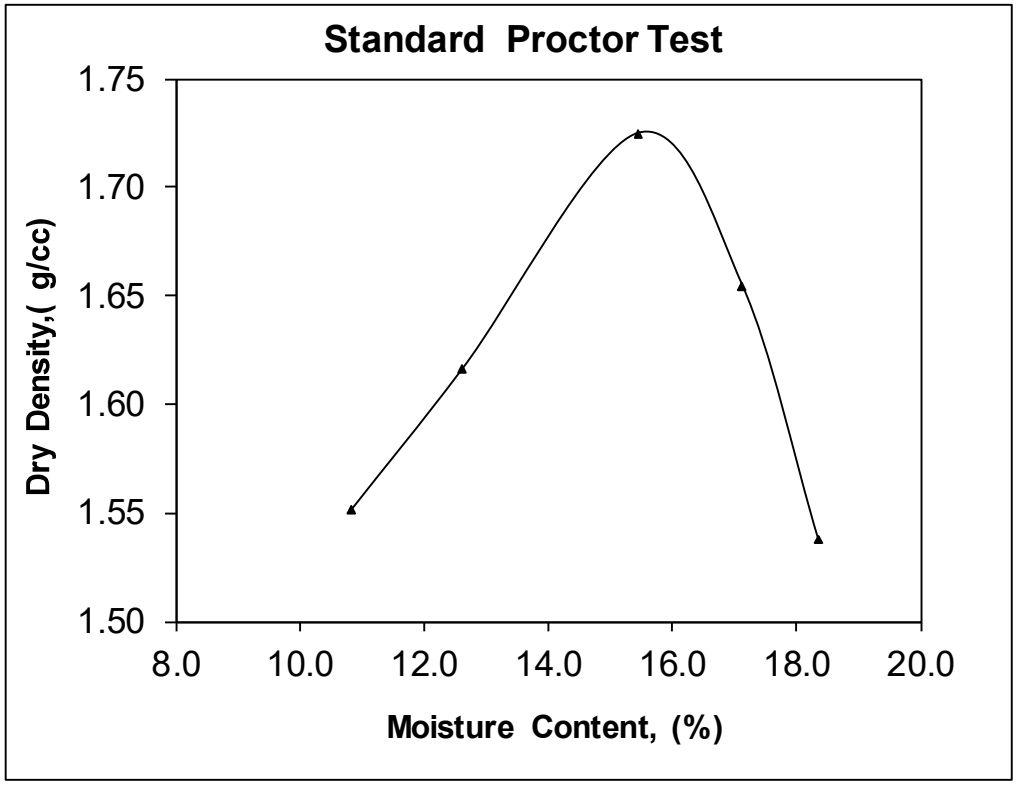
Test Results :

LOAD AT 2.5MM PENETRATION	155.6
LOAD AT 5 MM PENETRATION	210.5
C.B.R AT 2.5MM PENETRATION	**11.35**
C.B.R. AT 5 MM PENETRATION	**10.24**

STANDARD PROCTOR TEST

Pit No. : **TP-7** **Co-Ordinates : N = -236 E = 236**

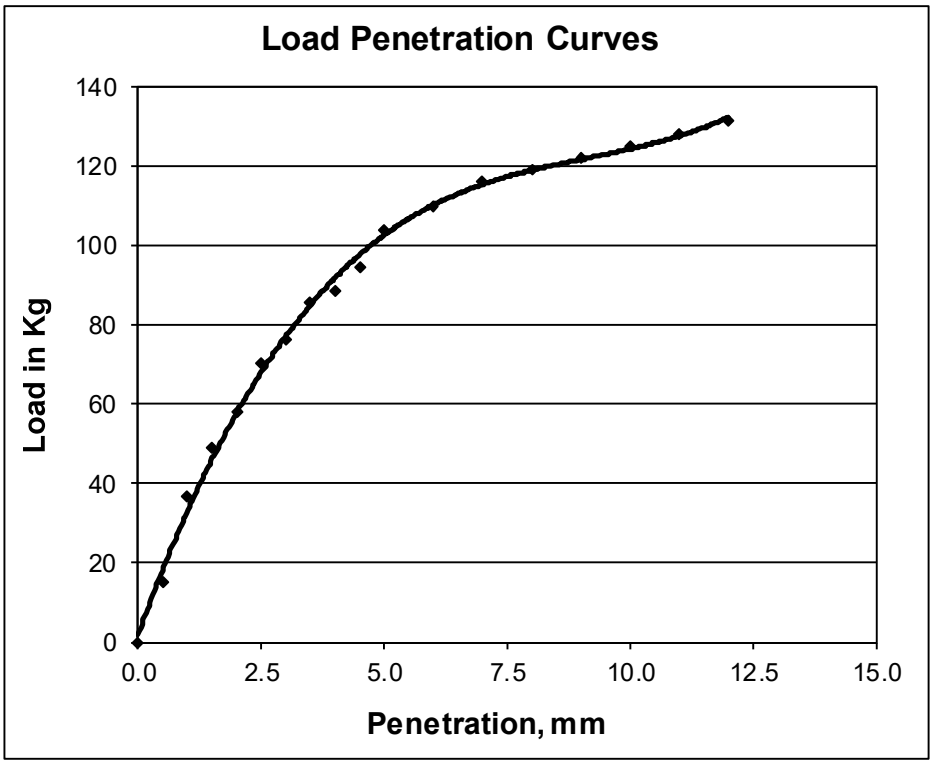
Sample ID. DS DEPTH = 0.3 m



Optimum Moisture Content, %	15.44
Maximum Dry Density, g/cc	1.73

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-7**	**Co-Ordinates : N = -236 E = 236**	
Sample ID.	DS	DEPTH =	0.3 m
OMC : %	15.44	**MDD , g/cc :**	1.73
		Proving Ring constant:	3.05

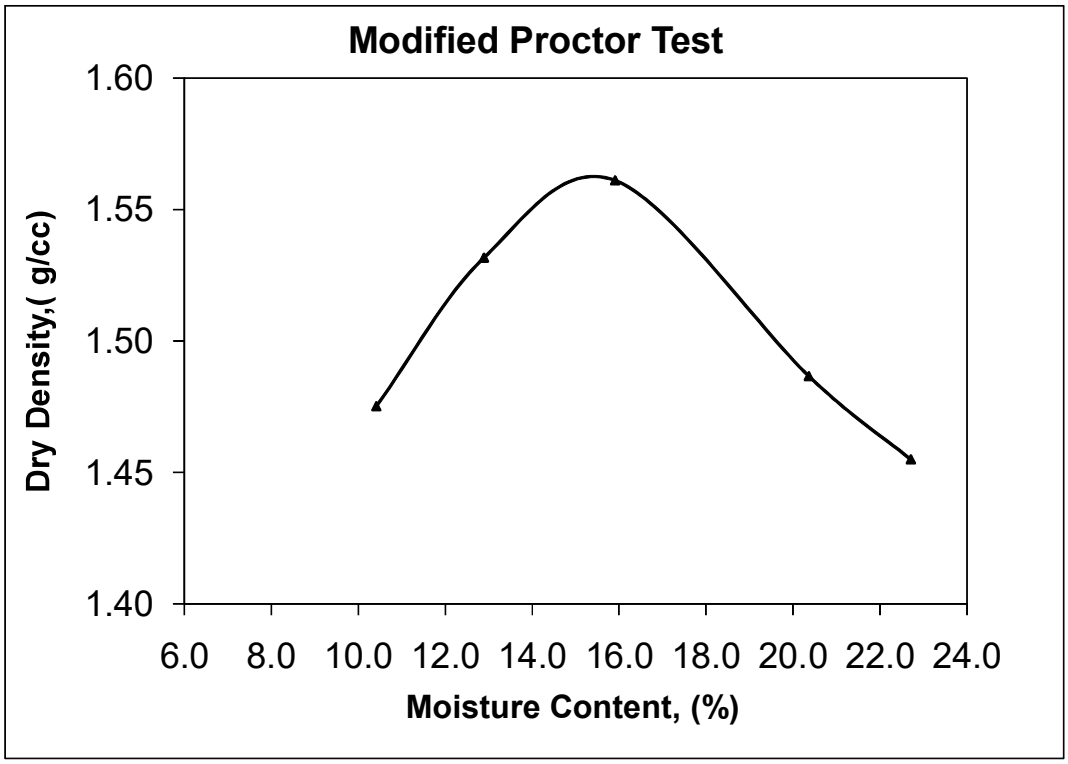


Test Results :

LOAD AT 2.5MM PENETRATION	70.2
LOAD AT 5 MM PENETRATION	103.7
C.B.R AT 2.5MM PENETRATION	**5.12**
C.B.R. AT 5 MM PENETRATION	**5.05**

MODIFIED PROCTOR TEST

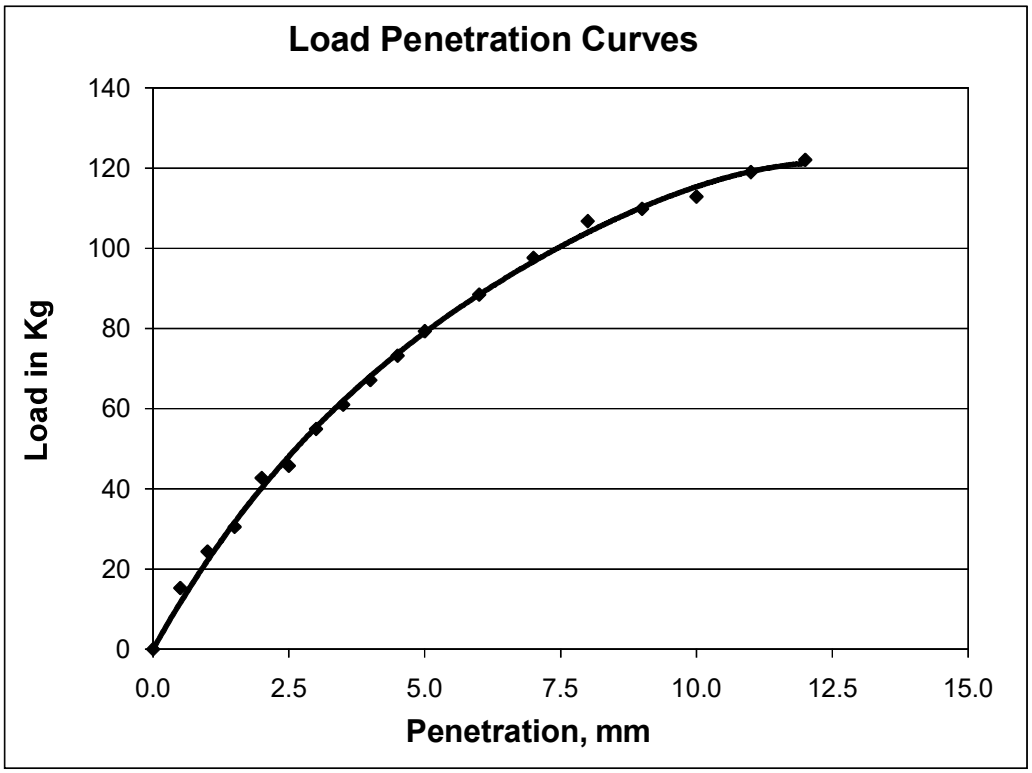
Pit No. :	**TP-8**	**Co-Ordinates : N = -748**	**E = 1309**
Sample ID.	DS	DEPTH =	0.5 m



Optimum Moisture Content, %	15.90
Maximum Dry Density, g/cc	1.56

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-8**	**Co-Ordinates : N = -748**	**E = 1309**
Sample ID.	DS	DEPTH =	0.5 m
OMC : %	15.90	**MDD , g/cc :**	1.56
		Proving Ring constant:	3.05

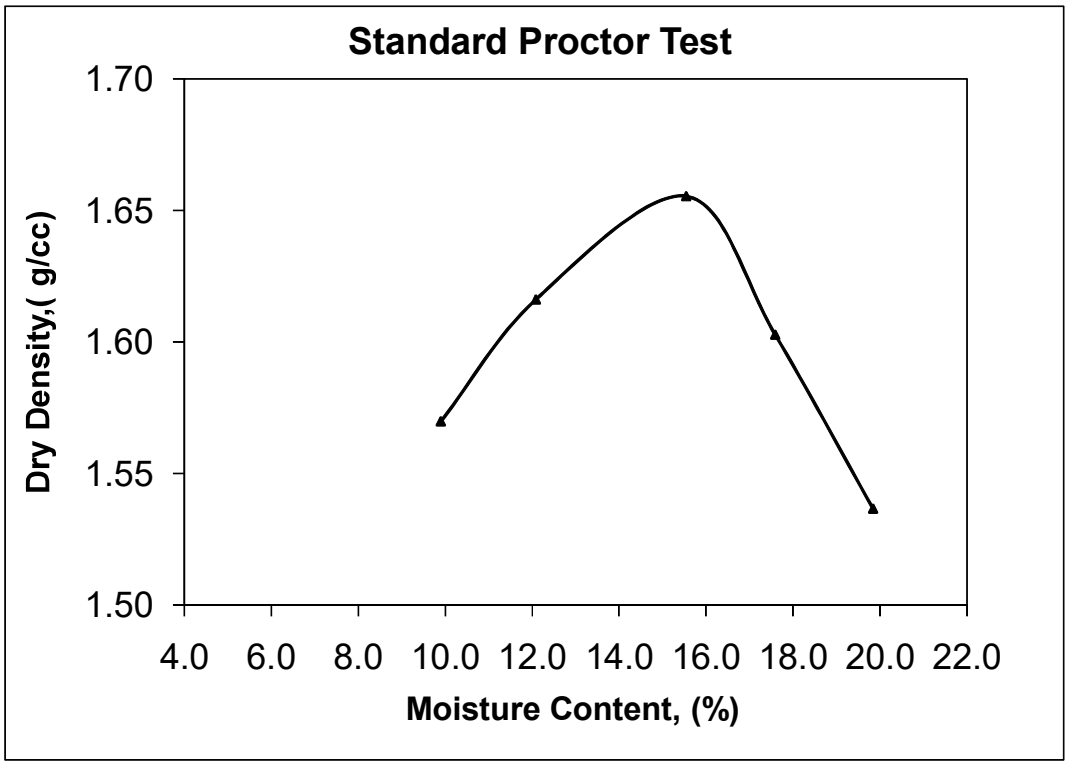


Test Results :

LOAD AT 2.5MM PENETRATION	45.8
LOAD AT 5 MM PENETRATION	79.3
C.B.R AT 2.5MM PENETRATION	**3.34**
C.B.R. AT 5 MM PENETRATION	**3.86**

STANDARD PROCTOR TEST

Pit No. :	**TP-9**	**Co-Ordinates : N = -32**	**E = 931**
Sample ID.	DS	DEPTH =	0.2 m



Optimum Moisture Content, %	15.54
Maximum Dry Density, g/cc	1.66

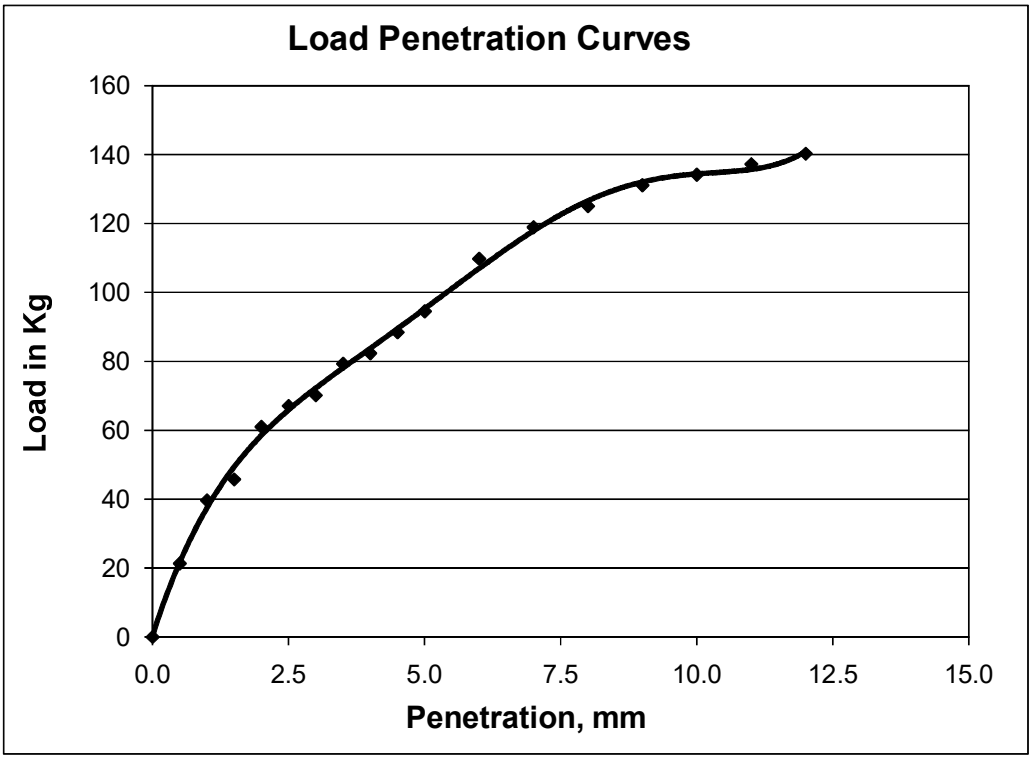
LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. : TP-9 **Co-Ordinates : N = -32 E = 931**

Sample ID. DS DEPTH = 0.2 m

OMC : % 15.54 **MDD , g/cc :** 1.66

Proving Ring constant: 3.05

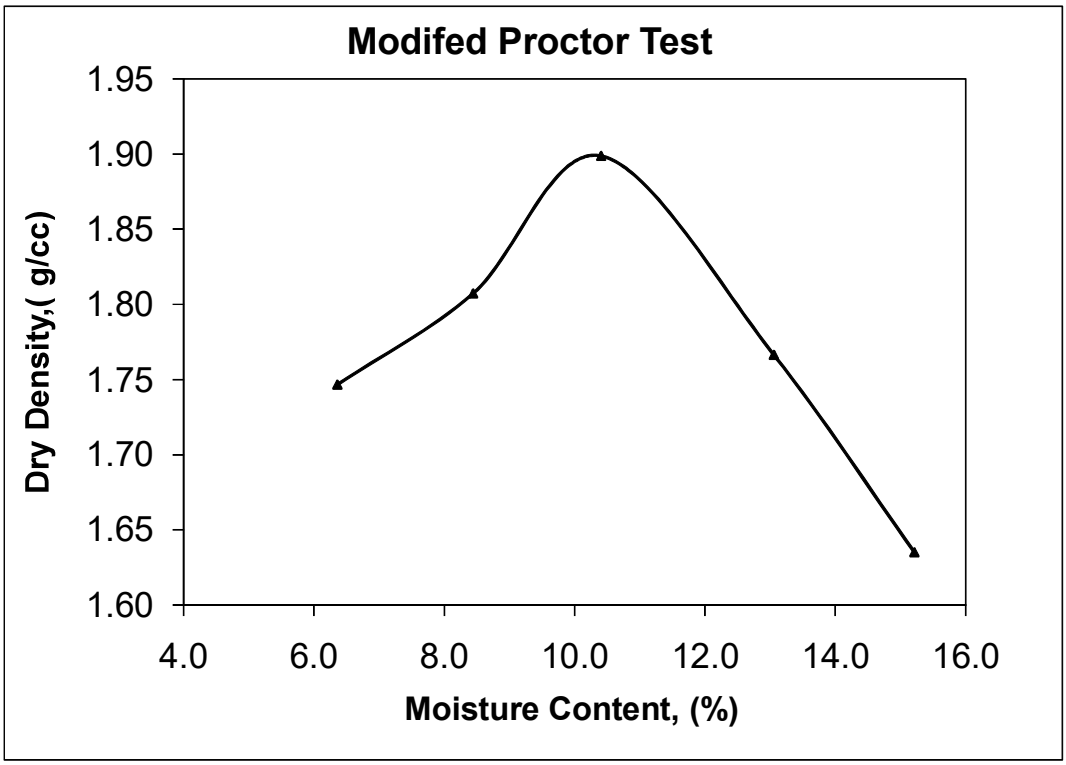


Test Results :

LOAD AT 2.5MM PENETRATION	67.1
LOAD AT 5 MM PENETRATION	94.6
C.B.R AT 2.5MM PENETRATION	**4.90**
C.B.R. AT 5 MM PENETRATION	**4.60**

MODIFIED PROCTOR TEST

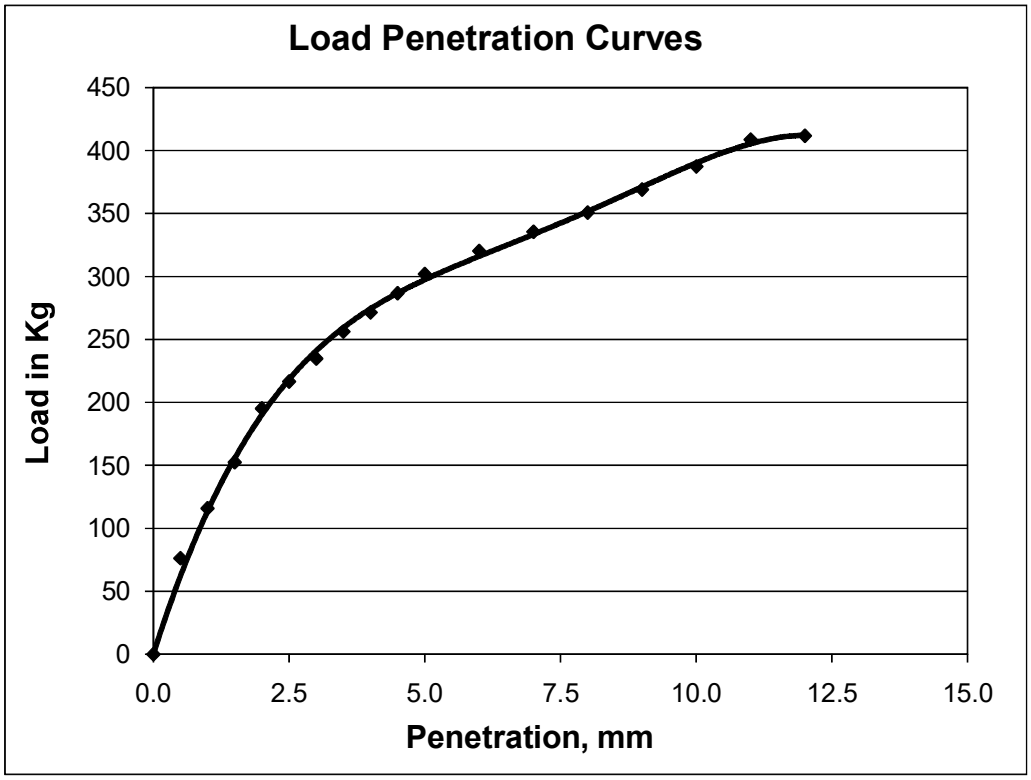
Pit No. :	**TP-10**	**Co-Ordinates : N = -318 E = 1693**	
Sample ID.	**DS**	DEPTH =	0.5 m



Optimum Moisture Content, %	10.40
Maximum Dry Density, g/cc	1.90

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-10**	**Co-Ordinates : N = -318 E = 1693**	
Sample ID.	**DS**	DEPTH =	0.5 m
OMC : %	10.40	**MDD , g/cc :**	1.90
		Proving Ring constant:	3.05



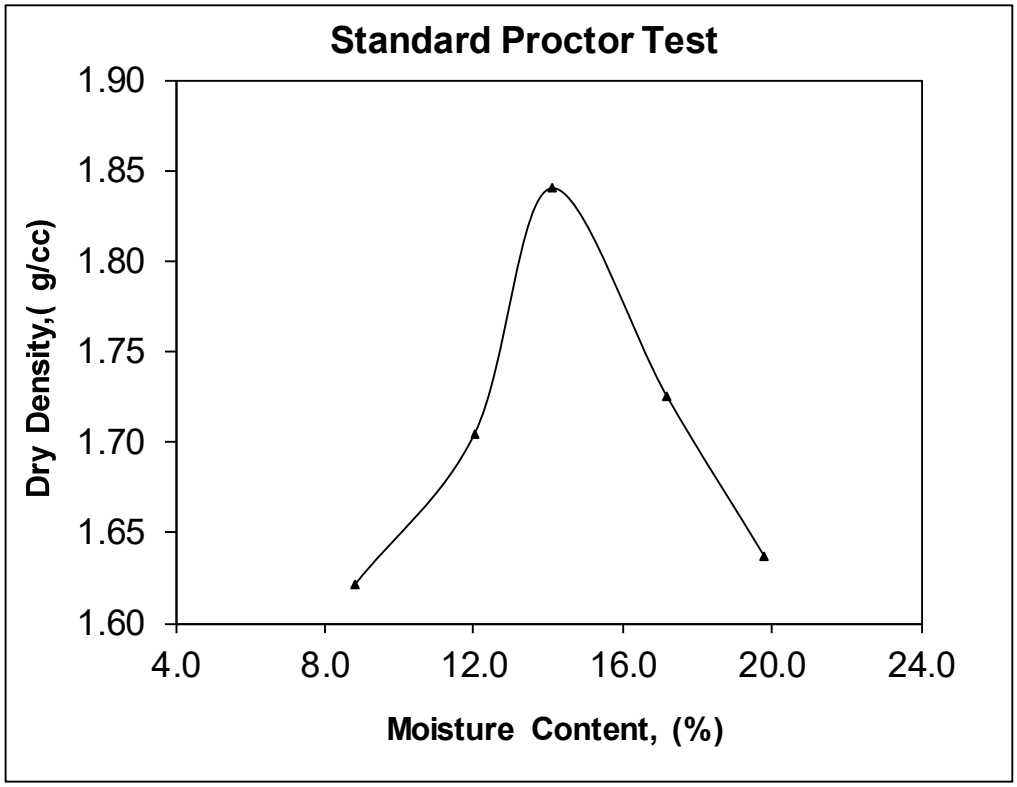
Test Results :

LOAD AT 2.5MM PENETRATION	216.6
LOAD AT 5 MM PENETRATION	302.0
C.B.R AT 2.5MM PENETRATION	**15.81**
C.B.R. AT 5 MM PENETRATION	**14.69**

STANDARD PROCTOR TEST

Pit No. : **TP-11** **Co-Ordinates : N =-280 E = 1.0**

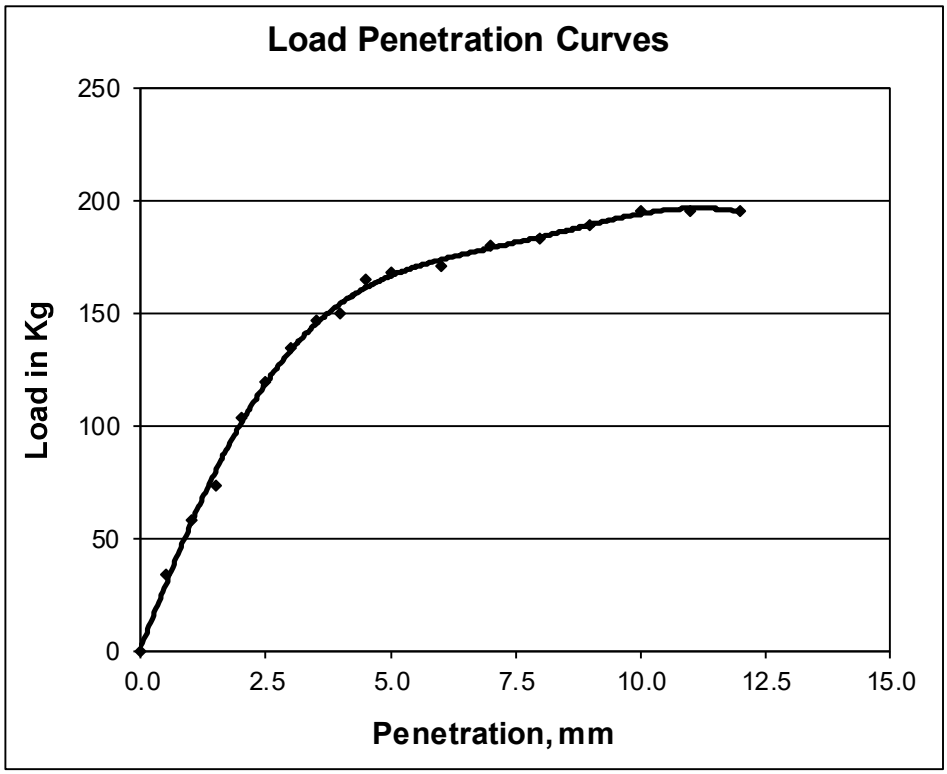
Sample ID. DS DEPTH = 0.35 m



Optimum Moisture Content, %	14.08
Maximum Dry Density, g/cc	1.84

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-11**	**Co-Ordinates : N =-280**	**E = 1.0**
Sample ID.	DS	DEPTH =	0.35 m
OMC : %	14.08	**MDD , g/cc :**	1.84
		Proving Ring constant:	3.05

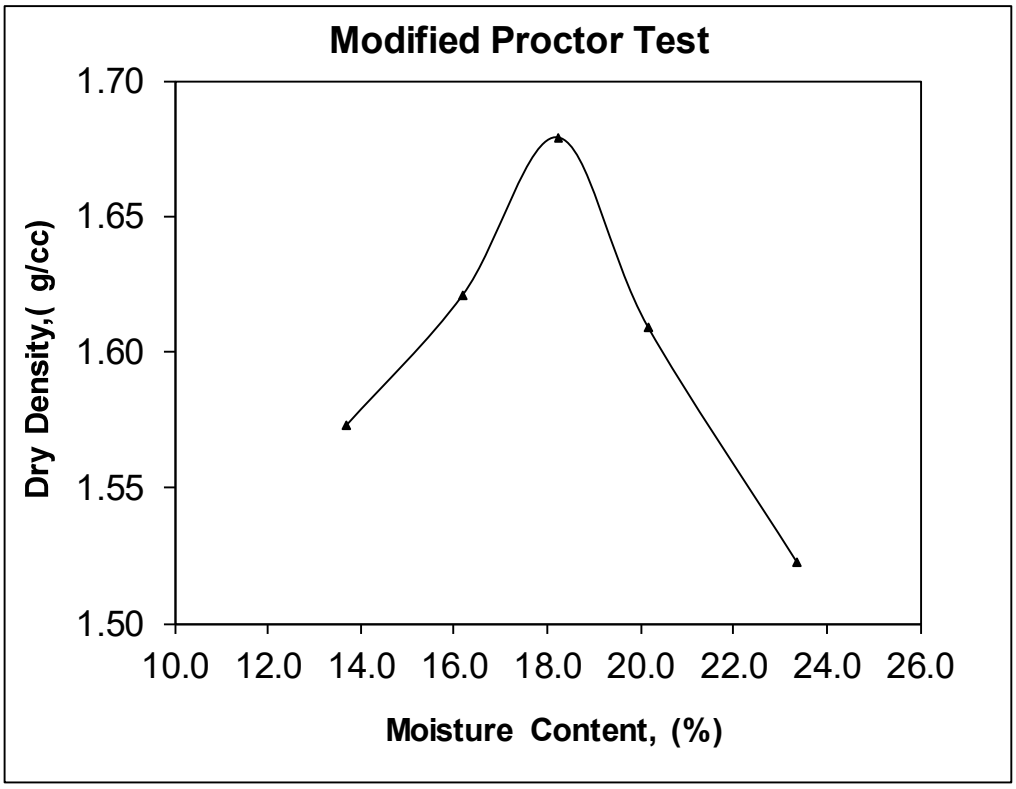


Test Results :

LOAD AT 2.5MM PENETRATION	119.0
LOAD AT 5 MM PENETRATION	167.8
C.B.R AT 2.5MM PENETRATION	**8.68**
C.B.R. AT 5 MM PENETRATION	**8.16**

MODIFIED PROCTOR TEST

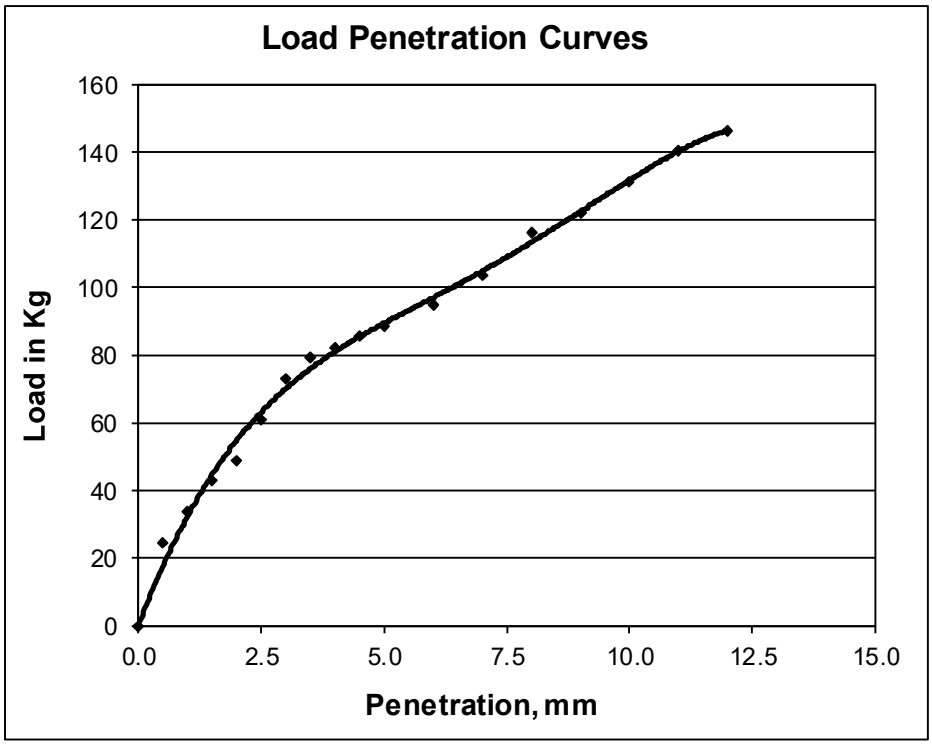
Pit No. :	**TP-12**	**Co-Ordinates : N = -280**	**E = 432**
Sample ID.	DS	DEPTH =	0.6 m



Optimum Moisture Content, %	18.24
Maximum Dry Density, g/cc	1.68

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-12**	**Co-Ordinates : N = -280**	**E = 432**
Sample ID.	DS	DEPTH =	0.6 m
OMC : %	18.24	**MDD , g/cc :**	1.68
		Proving Ring constant:	3.05



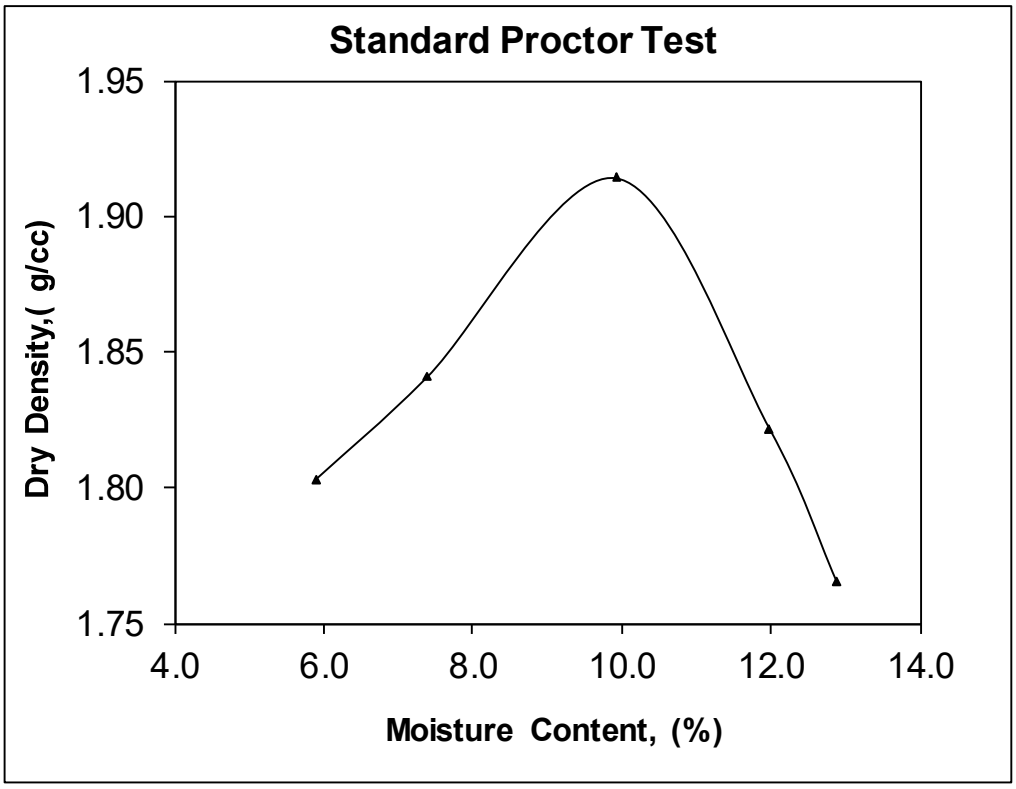
Test Results :

LOAD AT 2.5MM PENETRATION	61.0
LOAD AT 5 MM PENETRATION	88.5
C.B.R AT 2.5MM PENETRATION	**4.45**
C.B.R. AT 5 MM PENETRATION	**4.30**

STANDARD PROCTOR TEST

Pit No. : **TP-13** **Co-Ordinates : N = -280 E = 585**

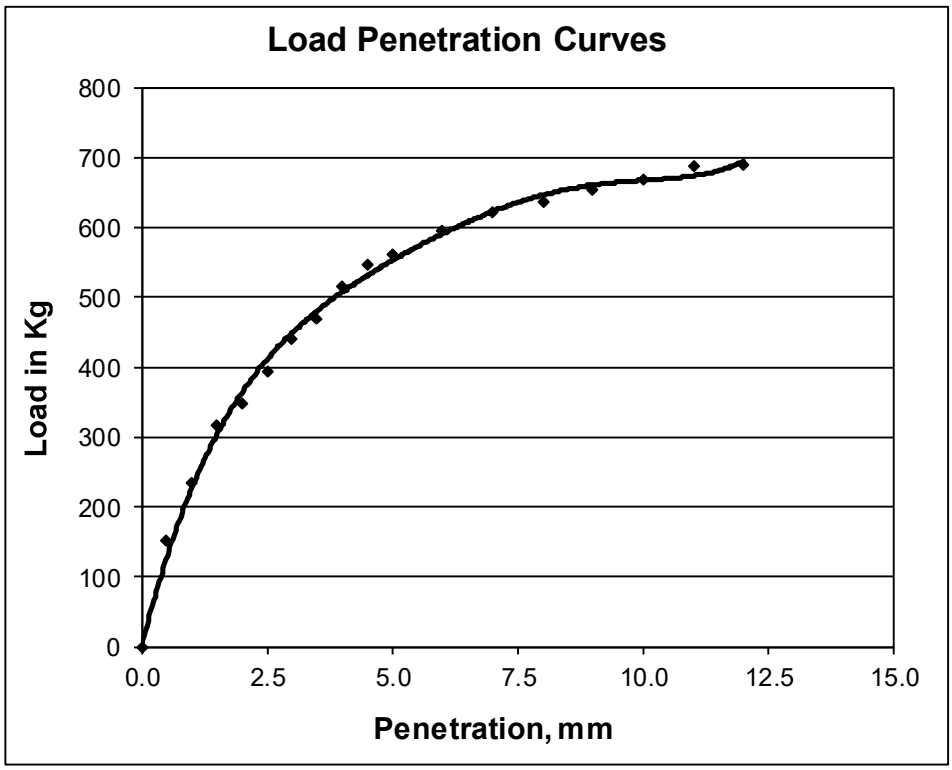
Sample ID. DS DEPTH = 0.7 m



Optimum Moisture Content, %	9.93
Maximum Dry Density, g/cc	1.91

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-13**	**Co-Ordinates : N = -280**	**E = 585**
Sample ID.	DS	DEPTH =	0.7 m
OMC : %	9.93	**MDD , g/cc :**	1.91
		Proving Ring constant:	3.05

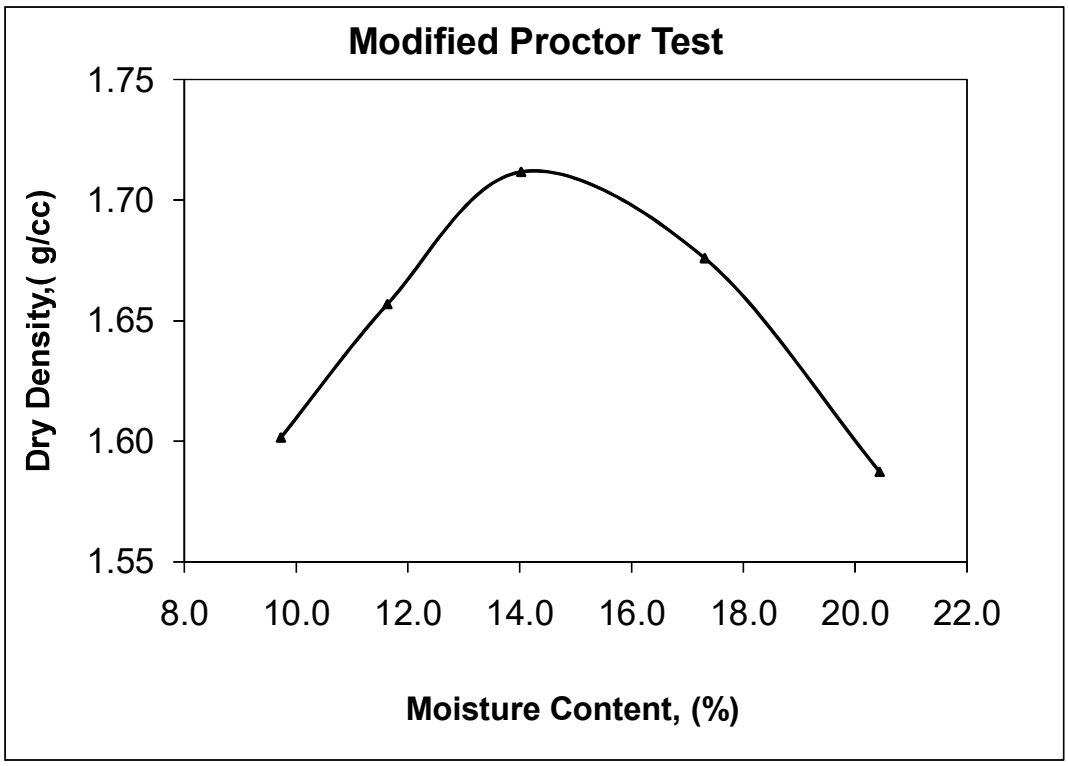


Test Results :

LOAD AT 2.5MM PENETRATION	393.5
LOAD AT 5 MM PENETRATION	561.2
C.B.R AT 2.5MM PENETRATION	**28.72**
C.B.R. AT 5 MM PENETRATION	**27.31**

MODIFIED PROCTOR TEST

Pit No. :	**TP-14**	**Co-Ordinates : N = -313**	**E =-361**
Sample ID.	DS	DEPTH =	0.8 m



Optimum Moisture Content, %	14.03
Maximum Dry Density, g/cc	1.71

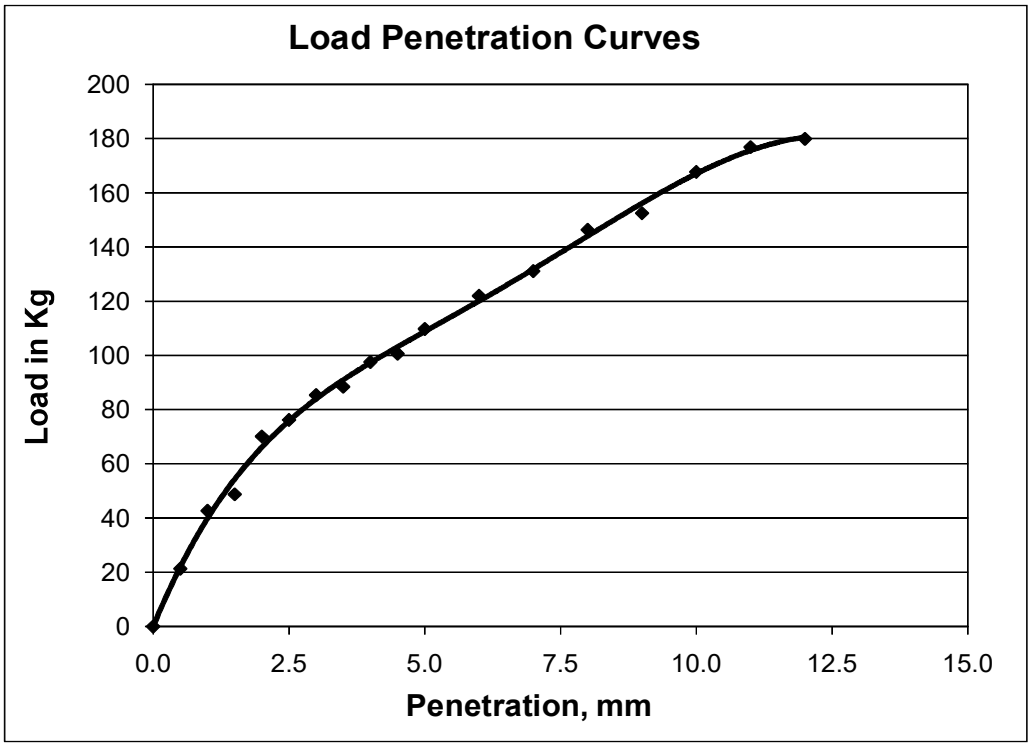
LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. : TP-14 **Co-Ordinates : N = -313 E =-361**

Sample ID. DS DEPTH = 0.8 m

OMC : % 14.03 **MDD , g/cc :** 1.71

Proving Ring constant: 3.05

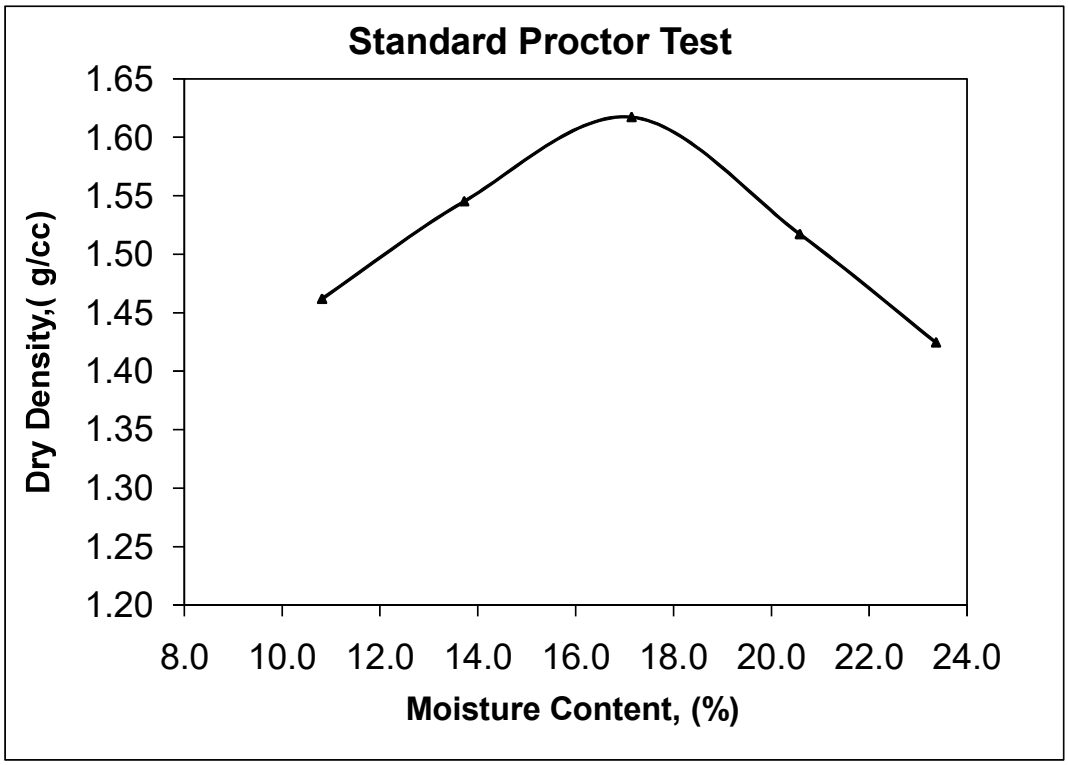


Test Results :

LOAD AT 2.5MM PENETRATION	76.3
LOAD AT 5 MM PENETRATION	109.8
C.B.R AT 2.5MM PENETRATION	**5.57**
C.B.R. AT 5 MM PENETRATION	**5.34**

STANDARD PROCTOR TEST

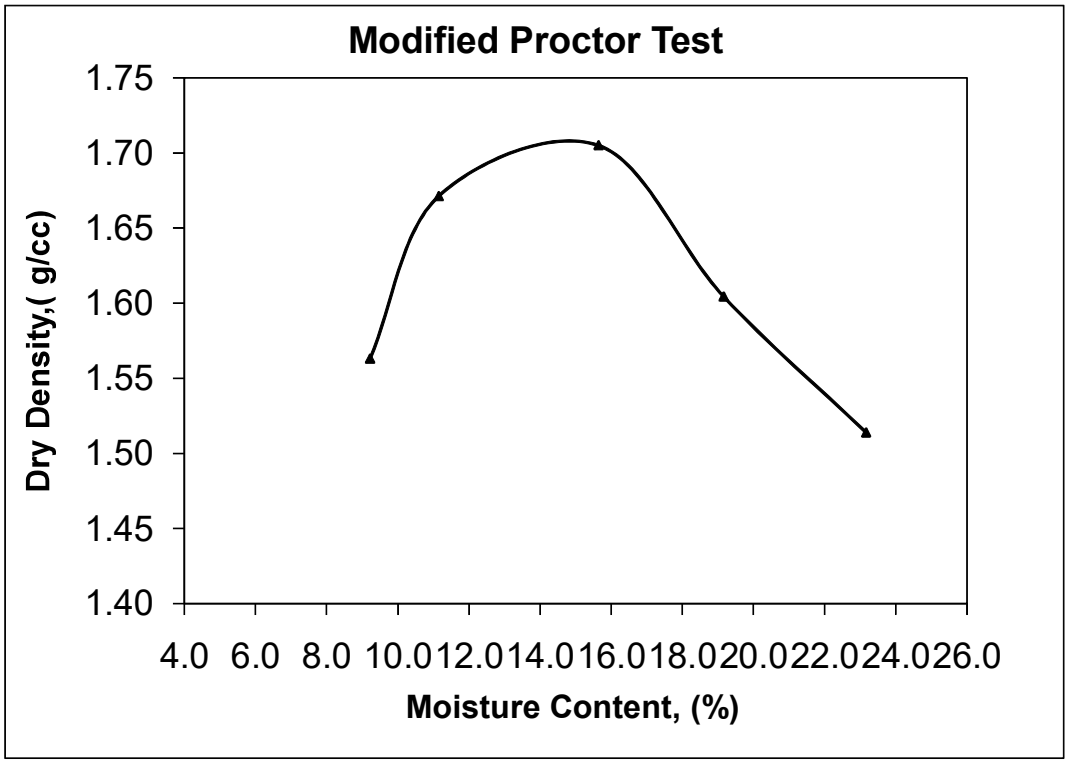
Pit No. :	**TP-15**	**Co-Ordinates : N = -404**	**E = 899**
Sample ID.	DS	DEPTH =	0.5 m



Optimum Moisture Content, %	17.14
Maximum Dry Density, g/cc	1.62

MODIFIED PROCTOR TEST

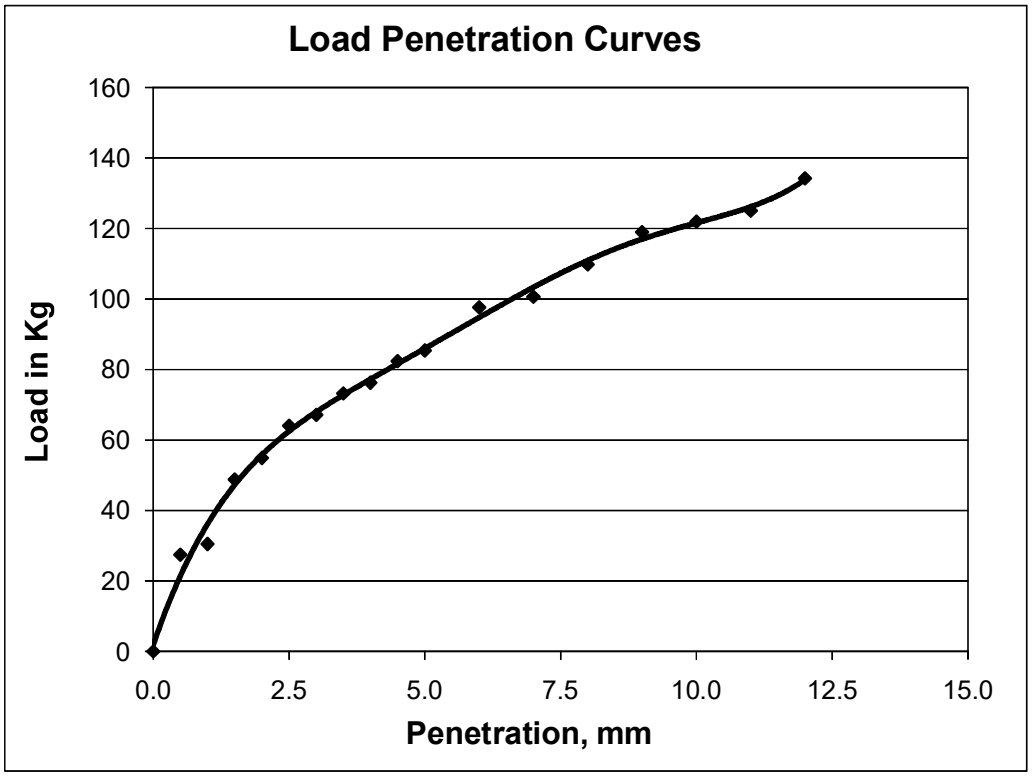
Pit No. :	**TP-16**	**Co-Ordinates : N = 926**	**E = 194**
Sample ID.	DS	DEPTH =	0.5 m



Optimum Moisture Content, %	15.65
Maximum Dry Density, g/cc	1.71

LABORATORY CALIFORNIA BEARING RATIO TEST (SOAKED)

Pit No. :	**TP-15**	**Co-Ordinates : N = -404**	**E = 899**
Sample ID.	DS	DEPTH =	0.5 m
OMC : %	17.14	**MDD , g/cc :**	1.62
		Proving Ring constant:	3.05



Test Results :

LOAD AT 2.5MM PENETRATION	64.1
LOAD AT 5 MM PENETRATION	85.4
C.B.R AT 2.5MM PENETRATION	**4.68**
C.B.R. AT 5 MM PENETRATION	**4.16**

PACKER PERMEABILITY TEST

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 3 Date : 25-02-2016

Location N = 0.00, E = 29 Weather : Summer season

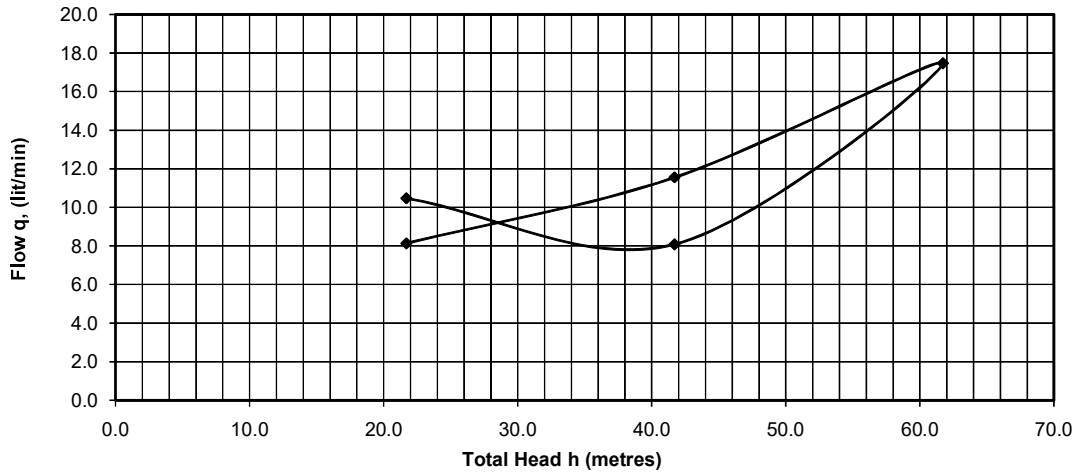
EGL ,RL(+),(m)= 81.699 Gauge Height Above Ground Level,m : 1.70 m

Test Depth, m 4 m Length of Test Section : 1.5 m

Water table : 7.5 m

Period	Gauge Pressure		Flow,q lit/min	READING AFTER				Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	8.1	4268.3	4319.45	4359.2	4399.85	**24.98**	**21.7**
2nd	4	40	11.6	4399.85	4450.2	4503.55	4561.3	**18.47**	**41.7**
3rd	6	60	17.5	4561.3	4640.4	4729.85	4817.15	**18.87**	**61.7**
4th	4	40	8.1	4817.15	4859.3	4898.6	4939	**12.92**	**41.7**
5th	2	20	10.5	4939	4962.1	4999.65	5052	**32.17**	**21.7**

Flow Vs Total head



Comments:

1] K_{av} = 21.48 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 3 Date : 24-02-2016

Location N = 0.00, E = 29 Weather : Summer season

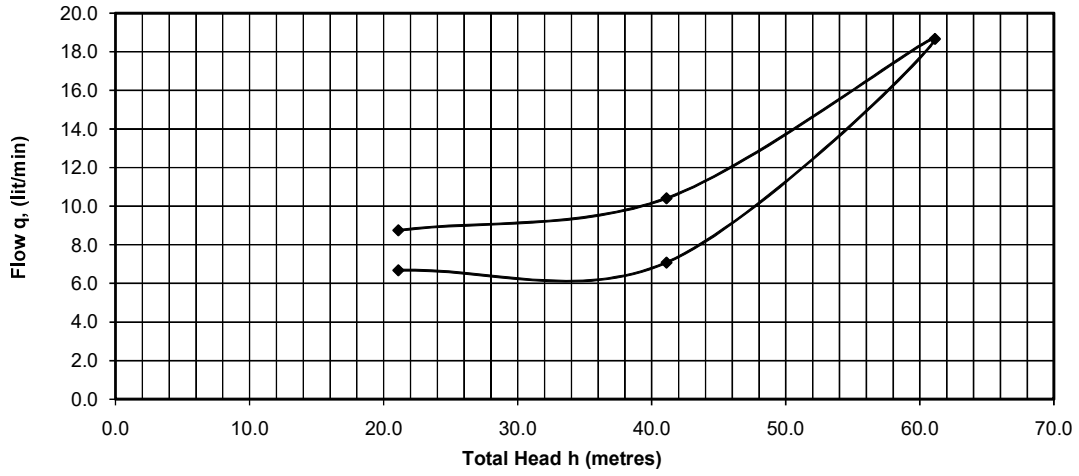
EGL ,RL(+),(m)= 81.699 Gauge Height Above Ground Level,m : 1.10 m

Test Depth, m 8 m Length of Test Section : 1.5 m

Water table : 7.5 m

Period	Gauge Pressure		Flow,q lit/min		READING AFTER			Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	6.7	3475	3526.45	3564.75	3598.15	**21.11**	**21.1**
2nd	4	40	7.1	3598.15	3649.3	3687.6	3723	**11.48**	**41.1**
3rd	6	60	18.7	3723	3767.55	3837.1	3930.4	**20.36**	**61.1**
4th	4	40	10.4	3930.4	3997.25	4045.15	4097.2	**16.89**	**41.1**
5th	2	20	8.8	4097.2	4143.6	4187.35	4231.1	**27.65**	**21.1**

Flow Vs Total head



Comments:

1] K_{av} = 19.50 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 20 Date : 24-02-2016

Location N = -205, E = 70 Weather : Summer season

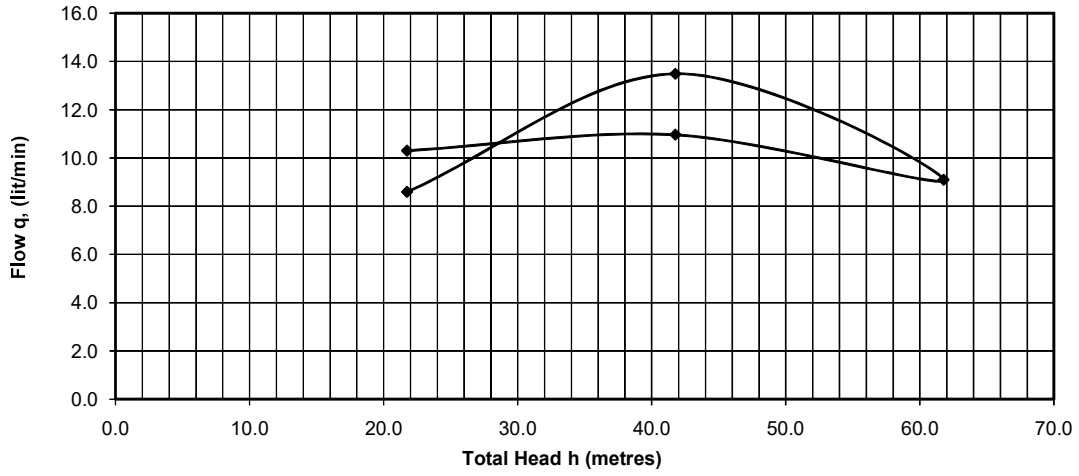
EGL ,RL(+),(m)= 81.187 Gauge Height Above Ground Level,m : 1.75 m

Test Depth, m 4 m Length of Test Section : 1.5 m

Water table : 9.50 m

Period	Gauge Pressure		Flow,q lit/min		READING AFTER			Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	8.6	2408	2461.2	2512.55	2555.5	**26.33**	**21.8**
2nd	4	40	13.5	2555.5	2604.65	2661.1	2728.55	**21.54**	**41.8**
3rd	6	60	9.1	2728.55	2821.7	2926.9	2972.35	**9.81**	**61.8**
4th	4	40	11.0	2972.35	3011.85	3066.4	3121.2	**17.50**	**41.8**
5th	2	20	10.3	3121.2	3173.9	3222.35	3273.85	**31.57**	**21.8**

Flow Vs Total head



Comments:

1] K_{av} = 21.35 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 20 Date : 23-02-2016

Location N = -205, E = 70 Weather : Summer season

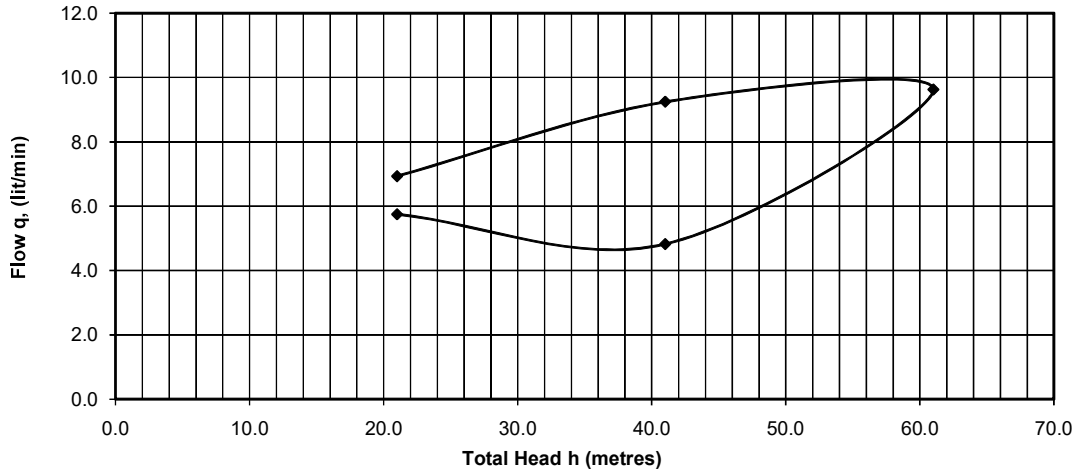
EGL ,RL(+),(m)= 81.187 Gauge Height Above Ground Level,m : 1.00 m

Test Depth, m 8 m Length of Test Section : 1.5 m

Water table : 9.50 m

Period	Gauge Pressure		Flow,q lit/min		READING AFTER			Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	6.9	161	187.9	224.4	259.05	**22.00**	**21.0**
2nd	4	40	9.2	259.05	320.7	366.15	412.35	**15.02**	**41.0**
3rd	6	60	9.6	412.35	451.15	477.35	525.45	**10.51**	**61.0**
4th	4	40	4.8	525.45	580.25	624.1	648.2	**7.84**	**41.0**
5th	2	20	5.8	648.2	669.8	705.5	734.25	**18.25**	**21.0**

Flow Vs Total head



Comments:

1] K_{av} = 14.73×10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 48 Date : 03-04-2016

Location N = 0.00, E = 627 Weather : Summer season

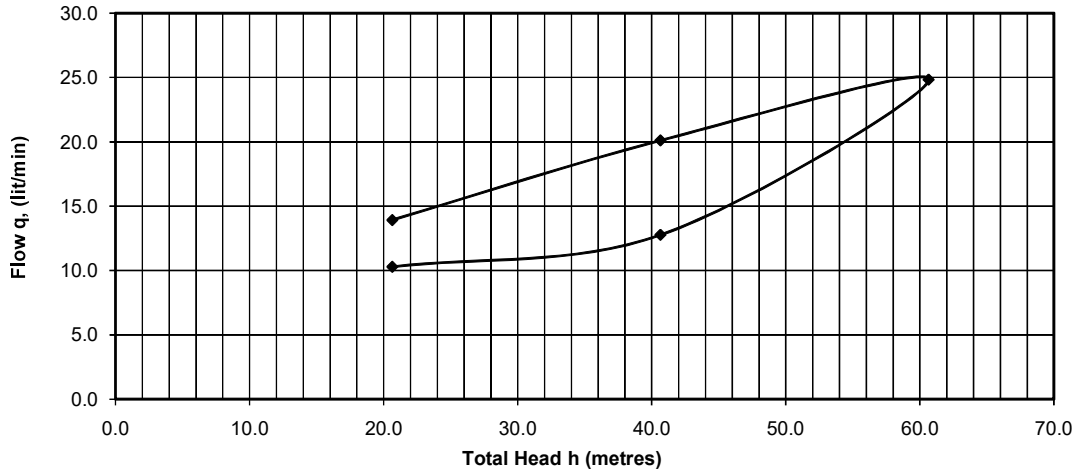
EGL ,RL(+),(m)= 84.008 Gauge Height Above Ground Level,m : 1.25 m

Test Depth, m 4 m Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min		READING AFTER			Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	7.8	17310	17350	17391.3	17430.5	**24.60**	**21.3**
2nd	4	40	10.8	17430.5	17485.6	17543.2	17597.4	**17.52**	**41.3**
3rd	6	60	17.0	17597.4	17686.1	17772.6	17857.4	**18.46**	**61.3**
4th	4	40	10.9	17857.4	17911.6	17963.8	18018.4	**17.65**	**41.3**
5th	2	20	8.0	18018.4	18062.7	18105.3	18145.1	**24.97**	**21.3**

Flow Vs Total head



Comments:

1] K_{av} = 20.64 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 48 Date : 03-04-2016

Location N = 0.00, E = 627 Weather : Summer season

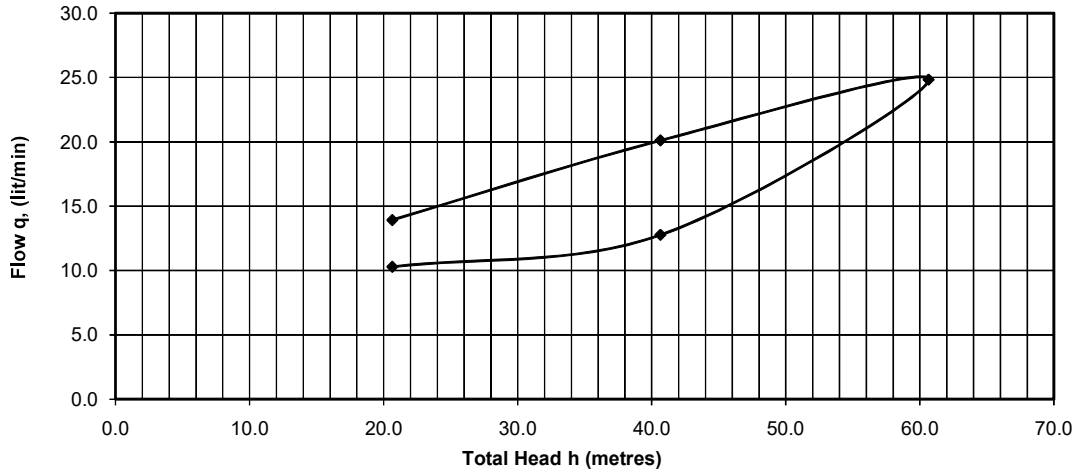
EGL ,RL(+),(m)= 84.008 Gauge Height Above Ground Level,m : 0.65 m

Test Depth, m 8 m Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min		READING AFTER			Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	13.9	16098	16118.5	16163.2	16232.8	**44.94**	**20.7**
2nd	4	40	20.1	16232.8	16410	16472.5	16573	**32.96**	**40.7**
3rd	6	60	24.8	16573	16721.1	16853.2	16977.3	**27.28**	**60.7**
4th	4	40	12.8	16977.3	17036.5	17098	17161.8	**20.93**	**40.7**
5th	2	20	10.3	17161.8	17210.8	17253.4	17304.8	**33.19**	**20.7**

Flow Vs Total head



Comments:

1] K_{av} = 31.86 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 66 Date : 07-04-2016

Location N = -157, E = 645 Weather : Summer season

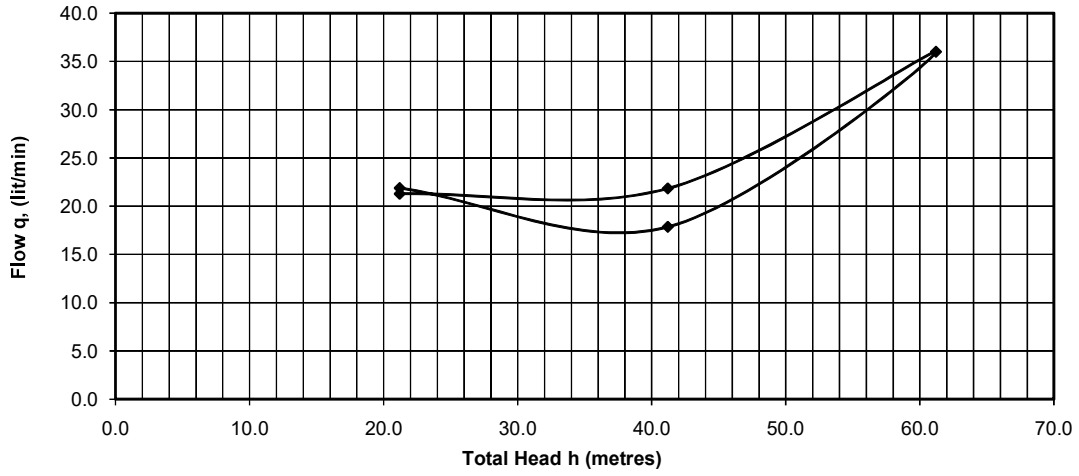
EGL ,RL(+),(m)= 85.885 Gauge Height Above Ground Level,m : 1.20 m

Test Depth, m 4 m Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min		READING AFTER			Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	21.3	20222	20299	20412.4	20518.8	**66.92**	**21.2**
2nd	4	40	21.8	20518.8	20631.1	20742.3	20851.4	**35.31**	**41.2**
3rd	6	60	36.0	20851.4	20976.2	21122.3	21302.3	**39.22**	**61.2**
4th	4	40	17.8	21302.3	21403.6	21499	21588.2	**28.87**	**41.2**
5th	2	20	21.9	21588.2	21677.5	21769.2	21878.6	**68.81**	**21.2**

Flow Vs Total head



Comments:

1] K_{av} = 47.82 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 66 Date : 06-04-2016

Location N = -157, E = 645 Weather : Summer season

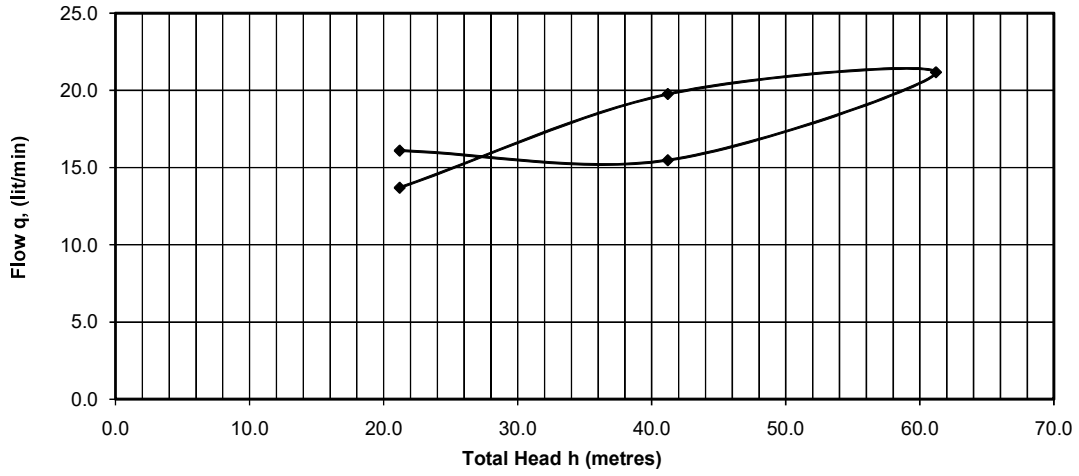
EGL ,RL(+),(m)= 85.885 Gauge Height Above Ground Level,m : 1.20 m

Test Depth, m 8 m Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min	READING AFTER				Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	16.1	18760	18852	18940.5	19021	**50.63**	**21.2**
2nd	4	40	15.5	19021	19152.2	19224.2	19301.6	**25.05**	**41.2**
3rd	6	60	21.2	19301.6	19546.3	19641.3	19747.1	**23.05**	**61.2**
4th	4	40	19.8	19747.1	19821.2	19878.4	19977.2	**31.97**	**41.2**
5th	2	20	13.7	19977.2	20039.1	20130.1	20198.6	**43.08**	**21.2**

Flow Vs Total head



Comments:

1] K_{av} = 34.76 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 121 Date : 03-03-2016

Location N = -426, E = -461 Weather : Summer season

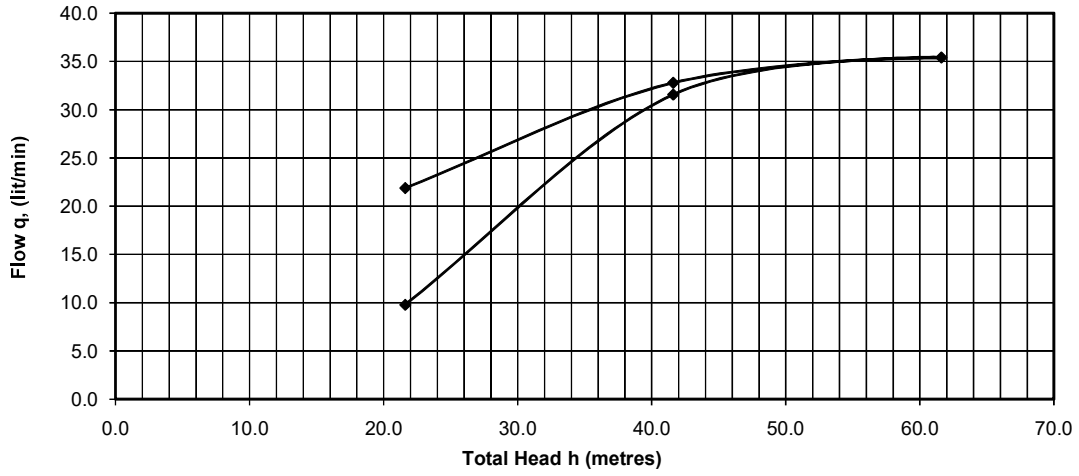
EGL ,RL(+),(m)= 79.756 Gauge Height Above Ground Level,m : 1.60 m

Test Depth, m 4 m Length of Test Section : 1.5 m

Water table : 5.2 m

Period	Gauge Pressure		Flow,q lit/min		READING AFTER			Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	9.8	7606	7665.4	7721.3	7770.2	**30.19**	**21.6**
2nd	4	40	31.6	7770.2	7809	7960.2	8118	**50.58**	**41.6**
3rd	6	60	35.4	8118	8306.1	8504.5	8681.5	**38.31**	**61.6**
4th	4	40	32.8	8681.5	8851.5	9000.3	9164.2	**52.53**	**41.6**
5th	2	20	21.9	9164.2	9283.7	9396.9	9506.2	**67.47**	**21.6**

Flow Vs Total head



Comments:

1] K_{av} = 47.81 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 121 Date : 03-03-2016

Location N = -426, E = -461 Weather : Summer season

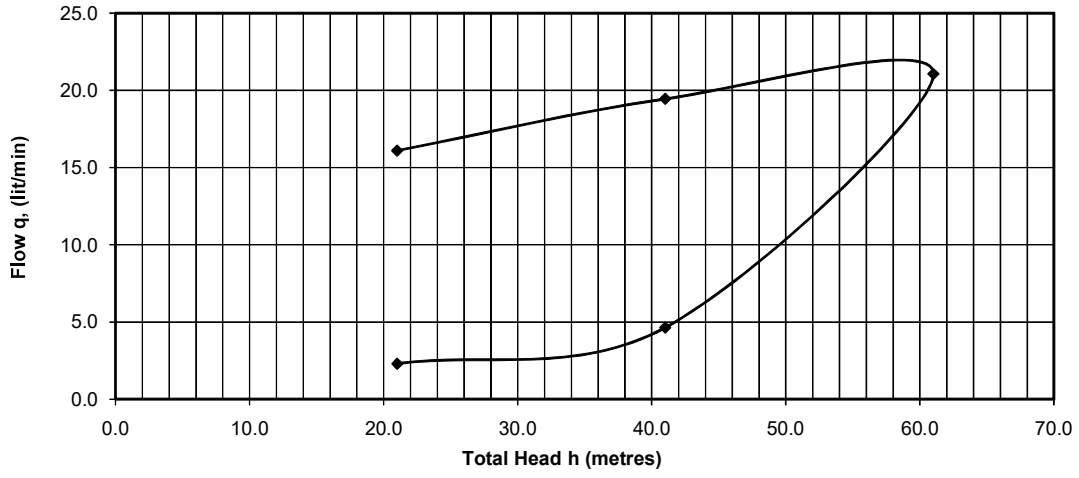
EGL ,RL(+),(m)= 79.756 Gauge Height Above Ground Level,m : 1.00 m

Test Depth, m 8 m Length of Test Section : 1.5 m

Water table : 5.2 m

Period	Gauge Pressure		Flow,q lit/min	READING AFTER				Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	16.1	6588.3	6670.8	6744.2	6824.7	**51.11**	**21.0**
2nd	4	40	19.5	6824.7	6935.2	7041.35	7138.6	**31.63**	**41.0**
3rd	6	60	21.1	7138.6	7233.45	7320.9	7426.2	**23.02**	**61.0**
4th	4	40	4.6	7426.2	7478.9	7511.4	7534.6	**7.54**	**41.0**
5th	2	20	2.3	7534.6	7551.4	7562.6	7574.1	**7.30**	**21.0**

Flow Vs Total head



Comments:

1] K_{av} = 24.12 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 135 Date : 20/4/16

Location N = -530, E = 428 Weather : Summer season

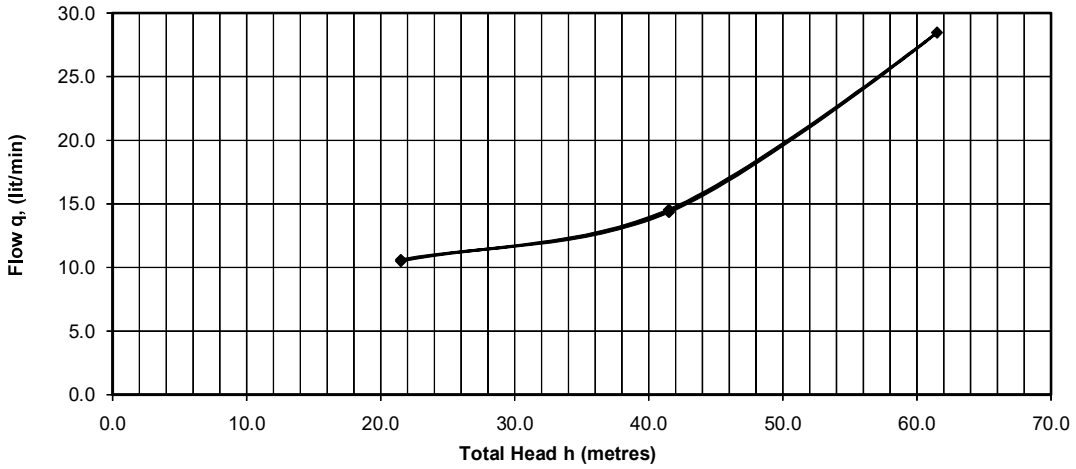
EGL ,RL(+),(m)= 82.422 Gauge Height Above Ground Level,m : 1.50 m

Test Depth, m 4 m Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min		READING AFTER			Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	10.6	23192.5	23252.8	23308.3	23361.3	**32.87**	**21.5**
2nd	4	40	14.4	23361.3	23450	23525.1	23596.9	**23.07**	**41.5**
3rd	6	60	28.5	23596.9	23739.4	23879.5	24021.8	**30.85**	**61.5**
4th	4	40	14.5	24021.8	24102	24178.3	24251	**23.36**	**41.5**
5th	2	20	10.5	24251	24309.4	24365.5	24418	**32.56**	**21.5**

Flow Vs Total head



Comments:

1] K_{av} = 28.54×10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 135 Date : 20/4/16

Location N = -530, E = 428 Weather : Summer season

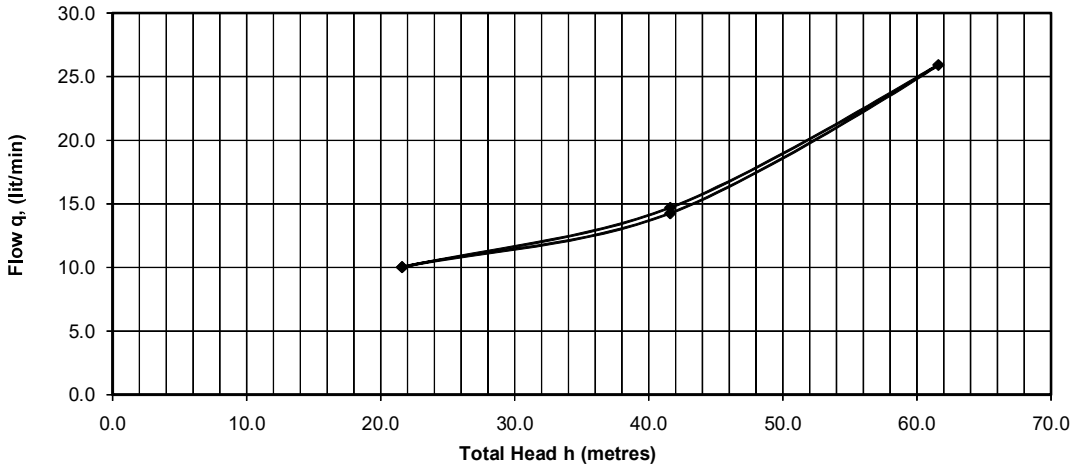
EGL ,RL(+),(m)= 82.422 Gauge Height Above Ground Level,m : 1.60 m

Test Depth, m 8 m Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min	READING AFTER				Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1^{st}	2	20	10.0	21980	22050.8	22103.1	22153.2	**30.93**	**21.6**
2^{nd}	4	40	14.7	22153.2	2224.6	22306.8	22380.3	**23.56**	**41.6**
3^{rd}	6	60	25.9	22380.3	22521	22656	22785.6	**28.05**	**61.6**
4^{th}	4	40	14.3	22785.6	22860.9	22931.7	23003	**22.85**	**41.6**
5^{th}	2	20	10.0	23003	23059.2	23113.8	23164	**30.99**	**21.6**

Flow Vs Total head



Comments:

1] K_{av} = 27.28×10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 150 Date : 05-04-2016

Location N = -915, E = 1400 Weather : Summer season

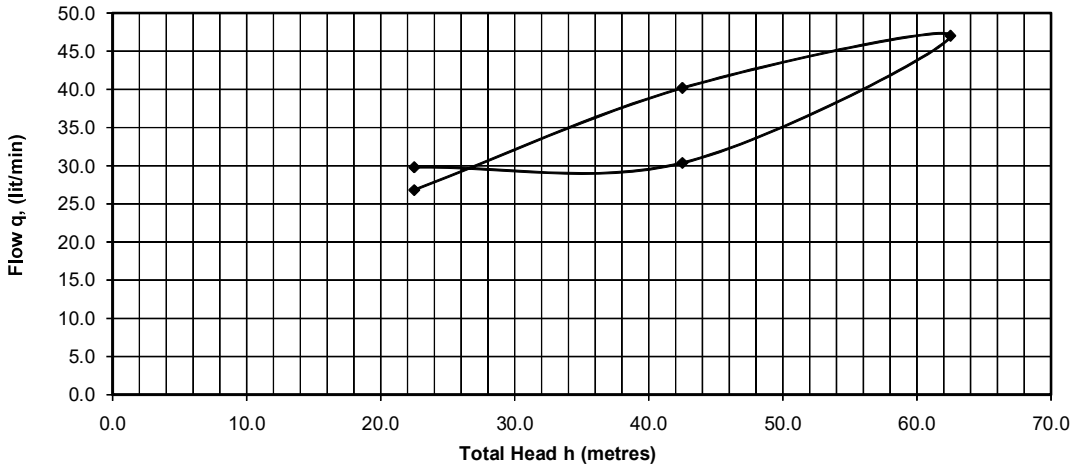
EGL ,RL(+),(m)= 81.626 Gauge Height Above Ground Level,m : 2.50 m

Test Depth, m 1.5 Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min		READING AFTER			Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1^{st}	2	20	26.8	27548.8	27653.5	27794.5	27928.5	**79.41**	**22.5**
2^{nd}	4	40	40.2	27928.5	28078.5	28265.9	28466.8	**63.03**	**42.5**
3^{rd}	6	60	47.0	28466.8	28692.5	28921.6	29156.7	**50.15**	**62.5**
4^{th}	4	40	30.4	29156.7	29378.4	29536.7	29688.5	**47.62**	**42.5**
5^{th}	2	20	29.8	29688.5	29857.8	30002.5	30151.5	**88.30**	**22.5**

Flow Vs Total head



Comments:

1] K_{av} = 65.70 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 150 Date : 05-04-2016

Location N = -915, E = 1400 Weather : Summer season

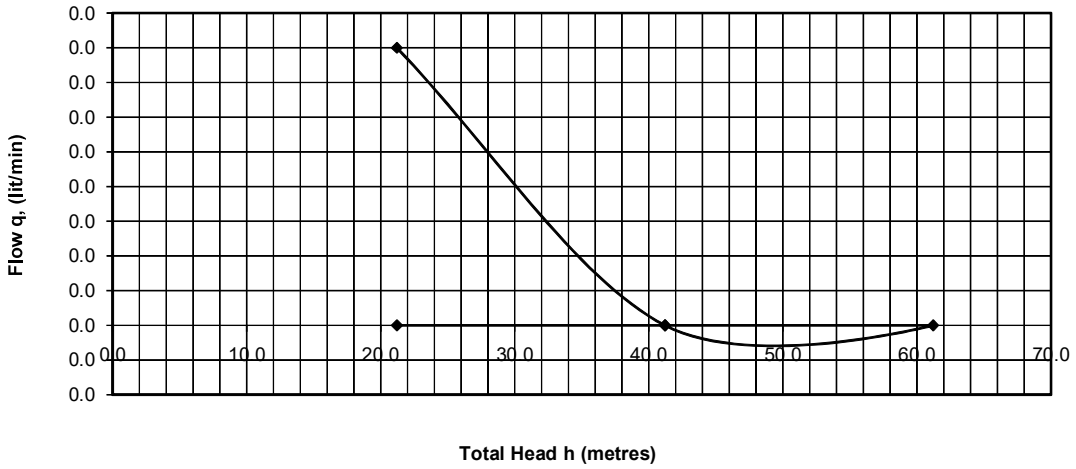
EGL ,RL(+),(m)= 81.626 Gauge Height Above Ground Level,m : 1.20 m

Test Depth, m 4 Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min	READING AFTER				Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	0.0	27491.9	27492.4	27492.7	27492.9	**0.13**	**21.2**
2nd	4	40	0.0	27492.9	27493.4	27493.4	27493.4	**0.00**	**41.2**
3rd	6	60	0.0	27493.4	27493.6	27493.6	27493.6	**0.00**	**61.2**
4th	4	40	0.0	27493.6	27493.7	27493.7	27493.7	**0.00**	**41.2**
5th	2	20	0.0	27493.7	27494.5	27494.5	27494.5	**0.00**	**21.2**

Flow Vs Total head



Comments:

1] K_{av} = 0.03×10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 150 Date : 05-04-2016

Location N = -915, E = 1400 Weather : Summer season

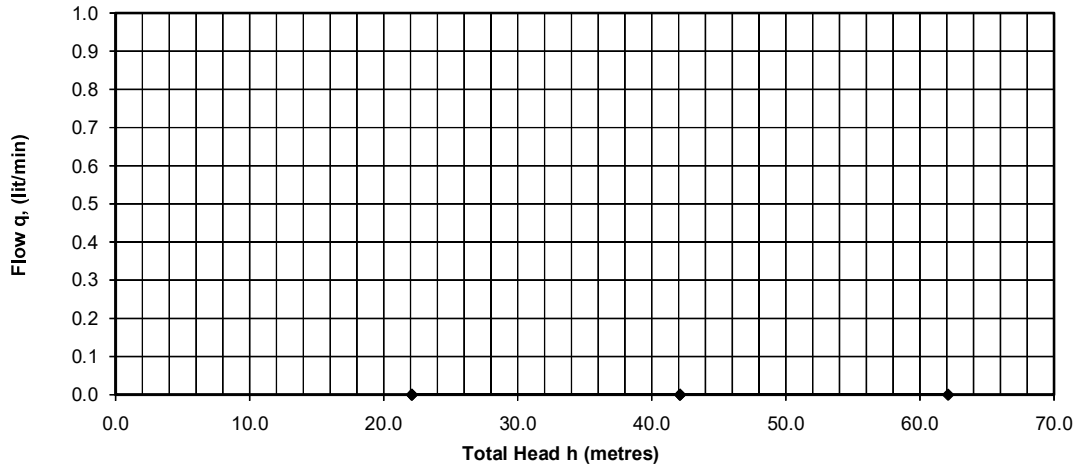
EGL ,RL(+),(m)= 81.626 Gauge Height Above Ground Level,m : 2.10 m

Test Depth, m 8 Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min	READING AFTER				Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	0.0	27444.5	27444.5	27444.5	27444.5	**0.00**	**22.1**
2nd	4	40	0.0	27444.5	27444.8	27444.8	27444.8	**0.00**	**42.1**
3rd	6	60	0.0	27444.8	27445	27445	27445	**0.00**	**62.1**
4th	4	40	0.0	27445	27445	27445	27445	**0.00**	**42.1**
5th	2	20	0.0	27445	27445	27445	27445	**0.00**	**22.1**

Flow Vs Total head



Comments:

1] K_{av} = 0.00 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 161 Date : 29/4/16

Location N = -434, E = 1627 Weather : Summer season

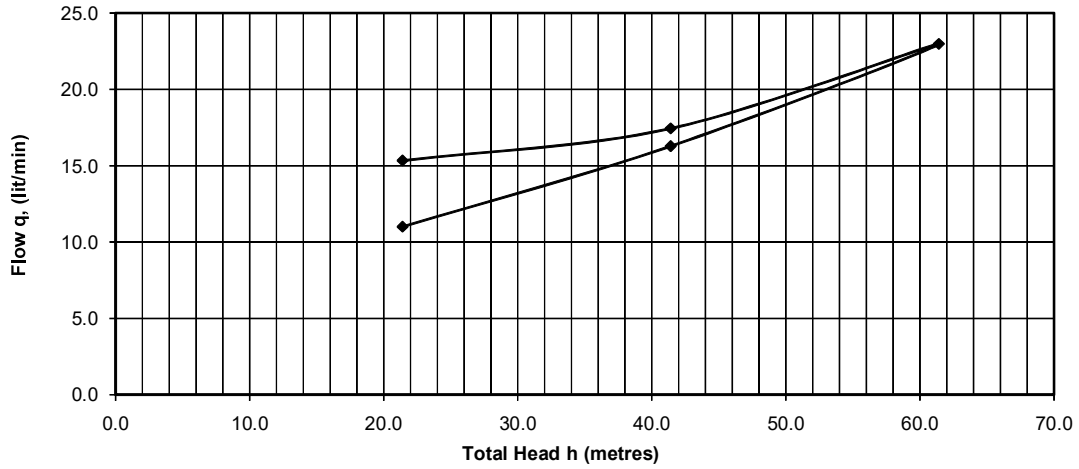
EGL ,RL(+),(m)= 89.075 Gauge Height Above Ground Level,m : 1.40 m

Test Depth, m 4 Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min	READING AFTER				Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	15.3	26156.3	26225.3	26295.4	26372.1	**47.79**	**21.4**
2nd	4	40	17.4	26372.1	26472.9	26561.7	26648.9	**28.08**	**41.4**
3rd	6	60	23.0	26648.9	26748.1	26858.9	26973.8	**24.95**	**61.4**
4th	4	40	16.3	26973.8	27050.6	27134.5	27215.9	**26.22**	**41.4**
5th	2	20	11.0	27215.9	27266.3	27316.3	27371.3	**34.27**	**21.4**

Flow Vs Total head



Comments:

1] K_{av} = 32.26 X 10^{-5} m/sec

PACKER PERMEABILITY TEST

Client : Bharat Heavy Electricals Limited

Project : Geotechnical Investigation and Topographical survey for 5x800MW Yadari Thermal Power Station at Veerlapalem Village, Dameracherla Mandal, Nalgonda District, Telangana Site

Bore Hole No : 161 Date : 29/4/16

Location N = -434, E = 1627 Weather : Summer season

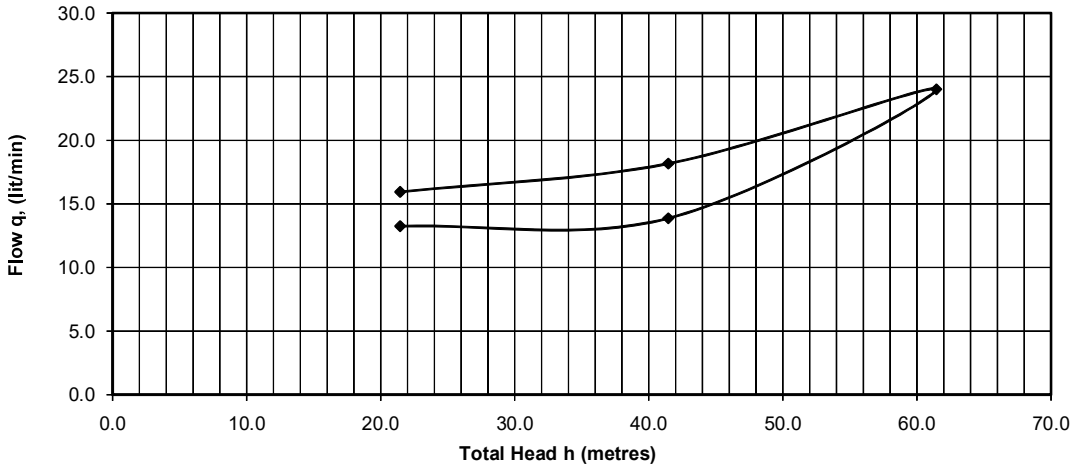
EGL ,RL(+),(m)= 89.075 Gauge Height Above Ground Level,m : 1.45 m

Test Depth, m 8 Length of Test Section : 1.5 m

Water table :

Period	Gauge Pressure		Flow,q lit/min	READING AFTER				Permeability	Total head, m
	Gauge Pressure kg/cm^2	Head of Water m		t =0 MIN	5 MIN	10 MIN	15 MIN	Lugeon, L lit/min/m/m	
1st	2	20	15.9	24890	24967.2	25048.3	25128	**49.54**	**21.5**
2nd	4	40	18.2	25128	25213.9	25301.8	25392.6	**29.21**	**41.5**
3rd	6	60	24.0	25392.6	25502.6	25616.7	25736.7	**26.04**	**61.5**
4th	4	40	13.9	25736.7	25811.3	25881.7	25951	**22.29**	**41.5**
5th	2	20	13.2	25951	26018.9	26083.1	26149.3	**41.15**	**21.5**

Flow Vs Total head



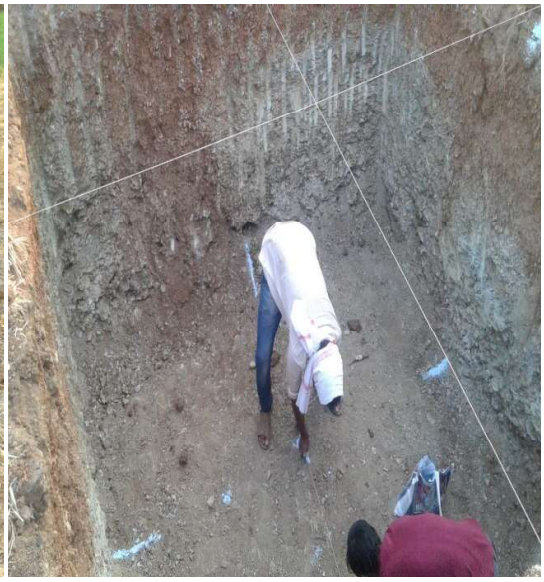
Comments:

1] K_{av} = 33.65 X 10^{-5} m/sec

PHOTOGRAPHS

Boreholes drilled

Trial Pit



BH1-1

BH1-2

BH2-1

BH2-2

BH2-3

BH4-1

BH5-1

BH5-2

BH7-1

BH7-2

BH8-1

BH8-2

BH8-3

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SECTION-XIV

TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

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SECTION-XIV

TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

1.00.00 SCOPE

The scope of work is to prevent the subterranean termites from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites while the building is under construction. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration. 19 parts of water shall be added to one part of chemical for achieving 1% concentration.

2.02.00 **Safety Precautions**

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemical shall be warned that absorption though skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contract with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion, workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see they are not allowed to contaminate wells or springs which serve as source of drinking water.

2.03.00 **Chemicals and Rate of Application**

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		**Concentration by Weight, Percentage**
Chlorpyrifos Emulsifiable (20EC) (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable (20EC) Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable (20EC) Concentrate (IS: 2682 - 1984)	:	1.0
Lindane (20 EC) (IS: 632)	:	1.0

2.03.01 **Treatment**

To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites shall be done as per IS 6313 (Part III).

2.03.02 **Treatment of Column Pits, Wall Trenches and Basement Excavations**

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (up to a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

If there is a concrete or masonry apron around the building, approximately 12mm diameter holes shall be drilled as close as possible to the plinth wall about 300mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to sock the soil below at the rate of 2.25 litres per linear metre.

2.03.03 **Treatment of Top Surface of Plinth Filling**

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.03.04 **Treatment of Soil Surrounding Pipes, Wastes and Conduits**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.03.05 **Treatment of Expansion Joints**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.03.06 **Treatment at Junction of the Wall and the Floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 **ACCEPTANCE CRITERIA**

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period at no extra cost to the owner.

4.00.00 **RATES**

The rates shall include the cost of labour and all other inputs including concentrated chemical involved in all the operations described above including making holes, channels etc. Rates shall be of complete work per unit length or area as stated in the Schedule.

5.00.00 **METHOD OF MEASUREMENT**

Complete work of anti-termite treatment shall be measured as per items stated in the BOQ.

This includes treatment, to foundations, walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work and no extra payment shall be made.

6.00.00 **I.S. CODE**

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981	:	Code of Practice of Anti-Termite Measures in Buildings (pre-constructional)
IS : 632	:	Gamma-BHC (Lindane) emulsifiable Concentrates
IS : 8944 – 1978	:	Chlorpyrifos emulsifiable concentrates
IS : 8963	:	Chlorpyrifos- Technical specifications
IS : 6439 – 1978	:	Heptachlor Emulsifiable
IS : 2682 – 1984	:	Chlordane Emulsifiable
		Pre-constructional chemical treatment measures.

TELANGANA STATE POWER GENERATION CORPORATION LIMITED
[TSGENCO]

CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SECTION - C

DATA FOR ARCHITECTURAL WORKS

(PART 2)

IN THIS DOCUMENT 1x800MW KOTHAGUDEM SHALL BE READ AS
5x800MW YADADRI THERMAL POWER STATION

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

All control rooms shall be provided with toilet facilities and drinking water supply facilities. All doors of toilet shall be of standard PVC door of approved make & colour.

6.07.00 **Interior Finish Schedule For Non Plant Buildings (Refer attachment for finish schedule)**

7.00.00 **DESIGN DATA FOR ARCHITECTURAL WORKS**

1	Brick works – internal and external	:	230 mm thick fly ash brick wall with 1:6 Cement- Sand mortar. All Brick work as mentioned in this document shall be with Fly Ash Bricks unless noted otherwise.
2	Half brick thick wall	:	1:4 cement: Sand mortar with 2 nos. 6 mm dia M.S. rod in every fourth layer.
3	One third brick wall	:	1:3 cement: sand mortar with 2 nos. 6 mm dia M.S. rod at every alternate layer.
4.	Damp proof course	:	40mm thick 1:1.5:3 Concrete with a 2% admixture of water proofing compound or as per manu-facturer's recommendation.
5.	Plaster: Exterior & rough side	:	20 mm thick with 1:4 cement-sand of interior brick wall mortar in two layers except where special finish provided.
	Interior	:	12 mm thick with 1:4 cement-sand mortar
	Ceiling	:	3 mm punning subjected to even surface at ceiling shall be maintained.
6.	White Cement Putty Punning	:	2 mm thick punning to be provided to all areas receiving acrylic emulsion or Acrylic Distemper paint.

7. Cladding for Power house

Providing and fixing of double skin insulated wall cladding system comprising of profiled external sheet manufactured out of 0.55mm TCT (Total Coated Thickness) permanently colour coated zincalume steel (150 gsm. Zinc – aluminium alloy coating total of both sides as per AS 1397: 1993) having 300 Mpa yield strength. The colour coating shall comprise of SMP. The inner sheeting shall be 0.50mm/0.6mm TCT of SMP coated zincalume steel 150 gsm. (Zinc – aluminium alloy coating mass total of both sides as per AS 1397:1993) having 550 Mpa yield strength or 180gsm galvanised of 240 mpa. The colour coating shall comprise of 20 microns finish coat over a 5-micron primer coat on the exposed side and a back coat of 5 microns over a primer coat of 5 micron on the reverse side.

The external sheet shall have 500mm cover width, 47mm high crests at 250mm centres with special male / female side laps and anti- siphoning feature to prevent leakage. The inner sheet shall have 980mm cover width 28mm high crests at 195mm centres with special male / female side laps and anti-siphoning features to prevent leakages. The inner sheet shall be fixed to the structure by means of self drilling fasteners no. 12-24 x 25 mm conforms to AS: 3566 Class-3 long at valley. Sub-girts of size 50mm x 50mm x 50mm manufactured out of 16G GI (1.6mm GI) 'Z' shape would be fixed the inner sheeting on face side at runner locations and outer sheeting shall be fixed with the help of concealed compatible interlocking clips and wafer head zinc coated self drilling fasteners / screws 4.2 x 25mm long on to the sub-girts. The clips shall be concealed and no fasteners are to penetrate the external sheeting. An insulation of 50mm thick Rockwool Insulation of density 48KG/M3 conforming to IS: 8183 shall be provided and fixed to the inner sheet and between the two sheets as per specification. If the insulation is made of polyurethane foam then the core in between the outer profiled sheet and the inner sheet will be formed out of polyurethane foam in 30mm thickness having a density of 40-45 kg/cum. The foam shall be in filled in between the outer and the inner sheet using a highly dedicated foaming machine and the entire process of forming the panel will be carried out at factory Panels may be prefabricated factory made panels or in-situ type. Wherever single skin metal cladding shall be used over brickwork, the material shall be same as the outer skin of insulated metal cladding system.

Approved Manufacturer : LLOYD Insulations (India) Ltd. TATA Blue Scope Steel, or similar approved.

8. False Ceiling : Aluminium pre-painted false ceiling, either lineal panel system or aluminium tile/plank system.

   Approved make : LUXALON by Hunter Dauglas, LLOYD, Armstrong, INTERARCH or similar approved.

   In other air-conditioned areas 12.5 mm Gypsum board/Mineral fibreboard /Calcium Silicate Board / Fibre Cement Board ceiling with aluminium grid will be used.

   Approved make : Saint Gobain Gyproc India Ltd, Armstrong, AMF, Everest, HILUX, Aerolite or similar approved.

9. Floor finish

a) Generally finish to utility areas shall be 40 mm thick heavy-duty patent stone with metallic hardener on concrete slab.

The heavy-duty overlay shall be ready-to-use, metallic aggregates based powder after application of epoxy based bonding agent of two components, solvent less epoxy resin based equal or similar to BASF's MASTERTOP 230i. It shall be formulated to meet the requirement of ASTM C881 Type 2, Grade 2, and Class B &C. The Bonding agent shall exhibit minimum open time of 6 hours and shall exceed the tensile strength of concrete in terms of its adhesive bond strength. The Floor topping product shall be high strength with compressive strength of 80 MPa at 28 days; flexural strength exceeding 8 MPa at 28 days. The product shall be capable of resisting metal crawler chassis and shall have abrasive wear less than 0.15 mg/cycle on H22 wheel, ASTM C501 test method. The product shall have adhesive bond strength in excess of 1.5 MPa when tested as per ASTM D4541. Curing of the layer to be done with non-degrading membrane forming curing & sealing compound shall be equal or similar to MASTERKURE 181, acrylic resin based formulation. The product shall comply with ASTM C 309 Class B. The product shall exhibit water loss not more than 0.55 kg/m2 in 72 hours when tested as per ASTM C156. The product shall form non-degrading abrasion resistance film which shall also exhibit capability as primer for subsequent protective coatings or bituminous overlays.

Approved make : BASF, Ironite or similar

b) For T.G. Hall (operating floor) Granite / Kota stone flooring finish will be as follows :

Minimum 18~20 mm thick polished Granite/ Kota stone slab or 600x600 mm tiles to be used over minimum 30 mm thick under-bed. Stones shall be hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions. Tolerance of ± 5 mm in dimensions and ± 2 mm in thickness will be allowed. During laying the slabs the edges of the slab shall be buttered with slurry of cement, mixed with pigment matching the colour of the stone slabs. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. Per. Sq.m. water sprinkled on to it and finished by buffing with felt or Hessian bobs.

c) For battery room, battery charger room, chemical laboratories, chlorination room etc., the areas handling corrosive liquids, overall 40 mm thick Acid and Alkali resistant vitrified tiles flooring with 20mm thick tiles with silica based epoxy mortar shall be used. Acid and Alkali resistant vitrified tiles with silica based epoxy mortar up to 2.1M height from finished floor level shall be used as dado. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado. Ceiling shall also be painted with Acid & Alkali resistant paint.

Approved Make	:	ENDURA of Jhonson, Chemstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. Or similar approved.
Paints	:	ICI, ASIAN Paints, Berger or similar approved.

d) For battery room finished with Epoxy Flooring (where required)

On the prepared substrate, one coat of a solvent free, resin based dispersion, Primer shall be applied. Density of the primer is around 1kg/lt and the mixing ratio of two components,

Comp A and B : 1:2.5 by weight

Over the primed surface, epoxy modified cementitious self levelling floor topping shall be laid maintaining the thickness of 2mm. The mixing ratio of three component Comp.A :Comp.B: Comp.C: 1:2.5:17 by weight, compressive strength at 30ºC approx. 45N/mm² after 28days, the mortar density is around 2.2 kg/lt.

Priming should be done again with a primer of two component product, comp. A: comp. B: 4:1 (By weight). Prior to mixing of these two components,only comp. A shall be stirred mechanically. When all of part B is added to part A, the mix is to be stirred for 3 minutes until a smooth consistency is achieved. Finally, after drying of the primer, two coats of high-build, slightly thixotropic, chemical resistant epoxy protective coating shall be applied as the top coat. Minimum 2 coats are required. This is two component products, comp. A: comp. B: 3:1 (by weight). The mixed density is 1.5kg/lt at 27^0 C. The system shall be allowed for curing for 3 days.

Approved Make : Sika India (P) Ltd., BASF or similar.

e) All areas of toilet, including W.C and urinal shall have vitrified ceramic tiles floor. Dado shall be of glazed tiles of minimum 5/6 mm thickness up to 100 mm higher than lintel level starting from finish floor level.

Approved Make : Ferrastone/Hardstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. , Marbonite, Kajaria, Nitco, Endura of H R Jonson, or similar approved.

f) Access Floor panel of size 600x600 mm shall be all steel welded construction, with an enclosed bottom pan of 49 hemispherical and 36 reverse cones and top plain sheet which are fuse welded at 129 locations to form a panel of an overall depth of 37 mm. The panel after cleaning, degreasing, phosphating by 11 tank process is coated with 40-60 micron epoxy coat and is heated to achieve maximum adhesion to the panel surface and corrosion resistance. The inner empty core of the panel is injected with a light weight fire retardant, non combustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 90% of the top surface area of the panel.

The panel is then laminated with 1.5/2.00 mm thick fire retardant floor grade Antistatic Laminate / ESD Laminate - PVC/ Conductive PVC on a semi –automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated are protected with black Conductive PVC edge trim 5mm wide on all sides. This edge trim is mechanically locked and sealed in place to avoid detachment

Sub structure installed to support the panel shall be suitable to achieve a minimum finished floor height of 65mm to a maximum of 600 mm from the existing floor level. Pedestal design shall confirm speedy assembly and removal for relocation and maintenance. The assembly shall provide easy adjustment of □evelling and accurately align panels for a maximum ± 25 mm in the vertical direction. Pedestals shall support an axial load without permanent deflection and an ultimate load as laid out in System Performance requirement. The Pedestal head assembly shall consist of a 90 x 90 mm x 4.00 mm embossed head mechanically riveted to a 100mm long 20mm Dia rolled formed stud and 2 check nuts for level adjustment and arresting vertical movement. The pedestal head shall consist of an anti-vibrational PVC cap, for Panel and stringer location.

The Pedestal Base assembly shall consist of 25.00 mm OD pipe of thickness 2.00 mm mechanically locked on a press for perpendicularity and then welded to a base plate of 125 x 125 x 2.50 mm thick with stiffening folds.

The sub structure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the manufacturer. All steel components shall be zinc electro plated.

The stringer is hot dipped galvanized steel cold rolled construction specially designed with ribs embossed on 3 sides for strength, lateral stability, and rolling loads and to support the panels on all four sides for alignment. The stringer to have a counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. The stringers shall be 21 x 32 x .8mm x570 mm length.

Approved make of Til e: Unitile® USF 1500 or similar approved.

g) Floor/staircase and the areas prone to slippage due to oil spillage etc. Shall be provided with non-skid floor finish.

h) 750 mm wide, minimum, R.C. paving as plinth protection, shall be provided around all buildings with surface drain of required size.

i) Risers and treads of concrete staircase of powerhouse shall be of white marble slab and in all other stairs; same shall be of Kota stone finish. 20/25 mm thick Kota stone finish excepting main stair riser and treads shall be of marble. All areas shall have 150 mm high skirting unless indicated otherwise in the specification.

j) For MCC and Switchgear rooms flexible electric insulated PVC synthetic sheet as per IS: 15652 2006 of Suntex Insulatic Pvt Ltd or similar shall be applied.

10. Doors and Windows

a) Hollow metal door at all levels shall be installed from ISO 9001-2000 certified Manufacturer. All hollow metal general doors with or without vision panel. Pressed Galvanised steel Single /Double leaf to required sizes which consist of frame, shutter, infill and finish as detailed below and conforming to IS 277.

Door frame shall be Single rebate profile of size 100 x 57 mm made out of 1.20 mm thick galvanised steel sheet (18 gauge). Frames should be Mitered and field assembled with self tabs. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement slurry if recommended on the clear masonry opening.

Door leaf should be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 0.8mm (22 gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid with steel stiffeners/ pads and reinforcement. The infill material shall be resin bonded honeycomb core. All doors should be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be as per joinery details with a screw on glass beading on the inside. The glass should be 5 mm clear toughened glass. Louvers when recommended should be site proof and shall be flush fixed on the external surface.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

Rate should include supply and installation of door and hardware.

Approved make	:	Shakti Met Dor, NCLSeccolor, Godrej, Gandhi Automation Pvt Ltd, or similar.
Approved Harrware	:	DORMA, Guardian

b) Hollow metal fire rated doors as per IS 3614 part-1 & part-2 for stability and integrity. Pressed Galvanized steel confirming to IS 277 with the following specification shall be used. Recommended fire door shall have doors tested at CBRI for maximum rating of 2 hrs with vision panel. Test certificates should be available for vision litters /panels as part of the fire door assembly. Independent glass test certificates will not be accepted. Manufacturer test certificate shall cover doors both single and double leaf and all doors supplied should be within the tested specimen, deviation in specification and sheet thickness other than what is mentioned in the test certificates are not allowed. Proper label confirming the type of door and the hourly rating is mandatory.

Door frame shall be double rebate profile of size 143 x 57 mm made out of 1.60 mm (16 gauge) minimum thick galvanized steel sheet. Frames shall be Mitered and field assembled with self tabs. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Rubber door silencers should be provided on the striking jamb. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. Once frame installed should be grouted with cement & sand slurry necessary for fire doors on the clear masonry opening.

Door leaf shall be 46 mm thick fully flush double skin door with or without vision lite. Door leaf shall be manufactured from 1.2 mm (18 gauge) minimum thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core. All doors shall be factory prepped for receiving appropriate hardware and provided with necessary reinforcement for hinges, locks, and door closers. The edges should be interlocked with a bending radius of 1.4 mm. For pair of doors astragals has to be provided on the meeting stile for both active and inactive leaf. Vision lite wherever applicable should be provided as per manufacturer's recommendation with a beeding and screws from inside. The glass should be 6 mm clear borosilicate fire rated glass of relevant rating of the door.

All doors and frames shall be finished with etched primer coating, stove zinc phosphate primer and thermosetting polyurethane aliphatic grade paint of approved colour. The door leaf and frame shall have passed minimum 250 hours of salt spray test.

Rate should include supply and installation of door and hardware set as mentioned in the door and hardware schedule.

Approved Make	:	Shakti Met Dor, Godrej, Navair, Promat, Gandhi Entrance Automation Pvt Ltd, or equivalent.
Hardware list	:	Hinge, Door closer, Panic Bar with external trim, Mortise lock & latch with lever handle for without panic bar door.
Approved Hardware	:	DORMA, Guardian

c) Main Entrance of Control Room, Control Equipment Room shall be provided with air-locked lobby with provision of double doors of aluminium framework with glazing with sensor operated sliding type for main entrance for main control room, service building, administrative building and double swing type for control equipment room, etc.. Doors of control room, control equipment room, computer room, etc. Shall be full glazed pre-coated minimum 3mm thick aluminium i.e. coloured anodized aluminium. Full glazed aluminium partition with airlock shall be provided along (B) row of Turbine hall operating floor where clear view is desired. Glazing between air-conditioned areas shall be single glass whereas that between air- conditioned and non-air- conditioned area shall be with hermetically sealed insulating glass.

Approved Make	:	Ferrastone/Hardstone of BOSS Profiles Ltd, RESTILE Ceramics Ltd. , Marbonite, Kajaria, Nitco, Endura of H R Jonson, or similar approved. al Systems of HYDRO, Hidalco, DORMA, or equivalent.

d) Doors of W.C. and shower shall be wooden panel door.

e) All windows and ventilators for prestigious buildings like power house, service building canteen, fire station, administrative building etc. Shall be glazed aluminium windows conforming to IS:1949 & IS: 1948.

Approved Make	:	Domal Systems of HYDRO, Hindalco, DORMA or equivalent.

f) Pre-coated (polyester painted) steel windows and ventilators may be used for auxiliary plant buildings.

Approved make : Ncl Altek & Seccolor Ltd.

g) Alternatively steel reinforced UPVC windows may be used for some non plant building if agreed by the owner.

Approved make : "Fenesta" by DSC Ltd.

Approved Hardware for doors shall be of HAFELE, DORMA or similar approved.

11. Rolling Shutters : Rolling shutters as per IS: 6248 with suitable operating arrangement (manual, mechanical and/or electric) according to size shall be provided in buildings to facilitate handling and transportation of equipment. The curtains of rolling shutter will be of interlocking scrolls made of hot rolled double dipped galvanised steel lath section of 18swg tested mild steel strips at 75mm rolling centres, locked with galvanised malleable iron clips. The bottom lath will be coupled to a locked plated fabricated from 3mm thick galvanised steel plate and security riveted with stiffening angles.

Approved Make : DiTEC-Gandhi Entrance Automation Pvt Ltd or similar approved.

12. **Glazing**

a) Glazing for windows in general shall be minimum 6 mm clear float glass and as mentioned elsewhere in this document.

b) Glazing in Control room between A/C & non-A/C area shall be with double glazed insulating glass consisting of 2 nos. 6 mm clear toughened float glass with 12 mm air gap in between, hermetically sealed.

c) Minimum 6.0 mm thick toughened float glass as specified below shall be provided in doors, partitions, windows of Power house building, Service Building, Administrative Building, etc.

d) 24mm thick insulated double glazing having 6mm thick tinted heat-reflecting type outer float glass and 6mm thick plain inner float glass with 12mm air gap & hermetically sealed shall be mounted on 15 micron coloured anodised aluminium frame suitable for structural glazing system. Quality of glass is given below.

e) 6mm thick Glass quality shall be toughened hard coated CVD on line process glass with Low –E coated in surface # 2 having (Light Transmission 82%, Visible light Reflectance- 10% & inside – 11%, Total Solar Energy Transmittance – 66% Reflectance–10% UV transmission – 49%, Solar Heat Gain Coefficient – 0.70 Shading Coefficient – 0.81 ,U – Factor Air 2.77 W/m2k, Sound Insulation – 31db outer lite.

f) 6 mm thick toughened Blue low E hard coated CVD on line process glass with Low –E coated in surface # 2 having (Light Transmission 35%, Reflectance 13%outside & inside – 30 %, Total Solar Energy Transmittance – 19%, Reflection – 9%, UV – 9 %, Solar Heat Gain Coefficient – 0.29 Shading Coefficient – 0.33,U –Factor Air – 1.9 W/m2k, Sound Insulation – 33db outer lite (# 2 surface) Glass with a combination of 6 mm thick toughen Optifloat clear 6mm glass inner lite (# 3 Surface) Now the two sheets of glass will be separated by an aluminium spacer leaving an air gap of 12.7 mm thick and sealed with the weather proof sealant.

Approved make : AIS of Asahi India Glass Ltd., Pilkington Glass India Pvt. Ltd. Saint Gobain or approved equivalent.

13. **Roof waterproofing**

a) Roof water proofing treatment shall be as follows :

i) For roofs with structural slope :

The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared sloped surface of RCC slab, application of elastomeric membrane shall be, a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with –

ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR of BASF or similar approved for thermal insulation as per HVAC requirement shall be laid over the finished separation layer of geotextile. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications :

- Colour: Orange
- Thickness: 50 mm
- Compressive strength: 200-220 kN/m2
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m2 oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore of BASF or similar approved shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on 15 mm thick cement plaster (1:4) which laid over 120 gsm non-woven polypropylene geo-textile separation layer. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

ii) For roofs having no structural slope: The cleaning and preparation of the substrate to which the elastomeric membrane is applied must be carried out thoroughly to leave a sound base for the application. Any laitance present on the surface must be removed mechanically. Release oil and other contaminants which may impair adhesion must be removed.

Over the finished well prepared flat surface of RCC slab, application of elastomeric membrane shall be a single component the liquid, cold applied, elastomeric polyurethane based, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with –

ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB. over the entire surface of SONOSHIELD HLM 5000R waterproofing membrane laying a separation layer of non-woven polypropylene geo-textile of 120 gsm followed by application of rigid insulation board expanded polystyrene BASF PERIPOR for thermal insulation as per HVAC

requirement shall be laid over the finished separation layer of geotextile. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications :

- Colour: Orange
- Thickness: 50 mm
- Compressive strength: 200-220 kN/m2
- Thermal Conductivity (K): 0.034 W/mK
- Thermal Transmittance (U): 0.5-0.6 W/m2 oC
- Water Absorption (% vol): <0.1% (by total immersion)

The top surface of the rigid polystyrene block of Peripore shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thick on screed concrete mix (1:2:4) grading having minimum 25 mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope laid over 120 gsm non-woven polypropylene geo-textile separation layer. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar under bed layer also.

iii) For other plant and non Plant buildings rigid insulating board (expanded / extruded polystyrene block) as per HVAC requirement shall be laid over screed concrete mix (1:2:4) grading having minimum 25mm thickness at the lowest point of the slope over R.C.C. slab and shall be laid as per the slope specified elsewhere in the specification. Top surface of rigid insulating board shall be finished with 15mm thick cement plaster (1:4) which shall be laid over Geo-textile membrane layer. Over the finished surface APP Bitumen membrane as specified below shall be laid and top of the Bitumen membrane shall be finished with pressed precast concrete tiles (size minimum 600 mm x 600 mm) of 20 mm thickness on 15 mm thick cement: sand (1:4) mortar underbed. Provision for thermal expansion of roofing tiles shall be kept by providing an expansion gap in both directions filled up with polysulphide joint sealant. The expansion gap shall be provided in the cement sand mortar underbed layer also.

h) APP modified Bituminous Polyester reinforced waterproofing membrane of Sika® WP Shield-104 P or similar approved shall be manufactured from a rich mixture of bitumen and selected polymers blended together to obtain excellent heat resistant, flexibility, UV resistance. Modified bitumen then coated onto a dimensionally stable carrier to obtain excellent tensile strength, tear and puncture resistance.

i) APP membrane shall conform to Conforms to: UEAtc, ASTM D146, DIN52123, ASTM D36, ASTM D5, UEAtc, ASTMD 5147, ASTM D4799.

j) Technical Data

- Chemical Base APP modified Bituminous Polyester
- Thickness 4mm
- Unit weight 4.40 kg/m2(According to UEAtc)

k) Mechanical / Physical Properties

- Tensile Strength (L/T) N/SCM - 800/600 (According to UEAtc,ASTM D146)
- Elongation at break (L/T) - 40/50 - (According to UEAtc,ASTM D146)
- Resistance to water pressure - No leakage - (According to DIN52123)
- Carrier (Polyster) weight- 180 g/m2
- Softening Point - 145 oC - (According to ASTM D36)
- Penetration - 15-25 at 25oC d mm-(According to ASTM D5)
- Tear resistance (L/T) N-170/180- -(According to UEATc)
- Water Absorption% (BSP)- <0.15-(According to ASTMD 5147)
- Heat Resistance- No Flow at 100oC-
- Resistance to Aging after 2000 hrs (Weather –O-Meter)- No Delamination- (According to ASTM D4799)

l) Concrete, mortar surfaces must be clean, free from grease, oil, and loosely adhering particles. Steel and iron surfaces must be free from scale, rust, grease and oil. All surfaces must be as true as possible.

m) Bituminous primer is to be applied to a clean, smooth and dry surface by brush, roller or spray. The material is to be Unrolled and align and re rolled correctly before torching. Overlaps should be minimum 100 mm. Gas burner is to be used to heat the substrate and thermo fusible film on the underside on lower face of membrane. When the thermo- fusible film melts after torching, the membrane is ready to stick. The membrane should be Rolled forward and press firmly against the substrate to bond. Both the overlaps shall be heated and the round tipped trowel shall be used for heating the same to smoothen and press into seam.

n) All angles and abutments should be sealed with extra care to ensure full bondage. The edges should be sealed well into the grooves.

iv) For Liquid, cold-applied PU elastomeric waterproofing membrane system shall be a single component the liquid, cold applied, of elastomeric polyurethane base, that cures by reaction with atmospheric moisture to form a tough but flexible waterproofing membrane of BASF's SONOSHIELD HLM 5000R or similar approved. It is elastomeric, seamless waterproof membrane applied in 2 coats to a DFT of 1.2 mm thick having a elongation capacity of over 600% and average tensile strength of 1 MPa, tear resistance as per GBT 19250-2003 >20N/m. The material shall comply with – ASTM C 836 National Std. of Canada 37.58 – M86 by CGSB.

Approved make of elastomeric membrane: SIKA India Pvt. Ltd, LLOYD, STP Ltd., BASF, Dr. Fixit or similar approved.

Approved make of APP Bitumen membrane: SIKA or similar approved.

Note : Waterproofing materials should be applied by the manufacturer authorised applicators only.

b) For efficient disposal of rainwater, the run off gradient for the roof shall not be less than 1:100. The top surface of finished roof shall be such as to allow quick drainage of rainwater.

c) The contractor shall give guarantee in writing for all works executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water proofing treatment work. The guarantee shall be for materials and workmanship for twenty (20) years. The mode of execution of the guarantee shall have to be acceptable to the owner.

d) Heavy duty HDPE pipes conforming to relevant BIS Code shall be provided to drain off rainwater from the roof. The numbers and size of down comers shall be governed by IS: 1742 and IS: 2527.

14. **Painting**

a) External masonry surfaces of all buildings shall be finished with External Quality Acrylic Emulsion paint similar to "Apex Ultima", "Weathergurd" / "Weathershield" over plaster. Granular textured paint may also be combined along with External Quality Emulsion paint to form suitable pattern on building façade.

b) Acrylic plastic emulsion paint of AkzoNobel/Asian Paints/ Berger or any other reputed make approved by TSGENCO shall be provided in control room, control equipment room, computer room, UPS room, all office areas and all air-conditioned areas including entrance lobby.

c) All other areas shall be provided with Acrylic Distemper paint.

d) Internal surface of walls in rooms for pumps, machineries and maintenance shall be painted with washable synthetic enamel paint of dark shade up to a height of 1.5 m above floor level.

e) Battery room and all other areas coming in contact with acid/alkali or other corrosive liquid shall be painted with acid/alkali resistant paint. Acid and Alkali resistant paint shall be applied up to the ceiling level above Acid and Alkali resistant tiles dado as specified elsewhere in this section. Ceiling shall also be painted with Acid & Alkali resistant paint.

f) All structural steel members including doors, windows, ventilators, louvers, rolling shutters and all other exposed steel work shall have two or more coats anti-corrosive paint and shall have minimum 110 micron DFT. Anti corrosive paint shall be Specification in short: Self Priming, Single Pack, Elastomeric (450% elongation), thermoplastic, fire retardant, Coating skin tensile strength 18 to 21 kg. Per sq. Cm. Antifungal, antibacterial, anticorrosive, non toxic graft Co-polymer coating of Meta Chem Paints & Adhesive Pvt. Ltd or similar approved.

g) All woodwork shall be painted with two coats of synthetic enamel paint over a coat of approved primer. DFT shall conform to IS specification.

h) All fire exits shall be painted in Post Office red.

i) Epoxy paint shall be provided in oil equipment room, oil canal, fuel oil pump house, etc.

j) Fire-proof putty in cable penetration on walls of cable spreader rooms shall be provided.

k) Paints shall be of reputed brand of reputed manufacturer like AkzoNobel/Berger/Asian Paints, Nerolac. For granular textured coating Vineratex, Heritage or equivalent shall be used.

15. Aluminium Composite Panels

1. Material:

   Total thickness of the panel – 4mmThickness of the aluminium skin – 0.5mm, Tensile strength of aluminium skin –120N/mm2 minimum, Density of PE core – 920 – 980 Kg/m3 (Non toxic grade Polyethylene) Coating – PVDF Adhesive film – DUPONT, USA Coating thickness (front foil) – 24µ - 30µ in PVDF including primer.15µ - 18µ in polyester coating. Coating thickness (back foil) – 4µ - 7µ polyester coating.

2. Colour – as indicated in the drawing.

3. Fixing arrangement – aluminium composite sheets shall be folded inwardly on four edges (without cutting the outer skin) to from Aluminium Composite Panels (ACP) and shall be riveted to the aluminium extruded section like angel or channel. There shall be at least one rivet at the both ends of the folded edge and other rivets shall be200mm c/c per panel edge/fold. Aluminium angles shall form a frame around the panel and shall be fixed to the steel sub-frame by self tapping screws with EPDM shim to prevent by-metallic reaction. The gap/groove between two adjacent panels shall be filled with Silicon sealant of approved make (GE or similar make) to prevent water seepage.

4. The supply fabrication and erection of ACP is inclusive of steel sub-base frame work if necessary as per site condition. The contractor shall take site measurement and produce working drawings for approval of engineer before erection of ACP.

5. Name of system provider- Eurobond, Alu Bond, or similar.

16. Poly Carbonate Sheet:

1. 4mm thick Compact Polycarbonate sheet, transparent or smoke tinted, of Lexan Polycarbonate or similar approved.

2. Framing shall be specially designed aluminium sections, colour anodised, with EPDM Gasket as per system provider's details. Framing shall be fixed to the steel structure as per site measurement, drawings and – Engineer in Charge.

3. Sealing of joints shall be done with Silicon sealant.

   Approved make : BAYER India, GE or similar

a) Shape of the roofing shall be as per drawing and approved by the owner.

b) Name of system provider – McCoy Architectural Systems Pvt. Ltd. / Citadel Architectural Solutions Pvt. Ltd. / or equivalent.

c) System provider shall prepare and submit the detailed working drawing for approval of engineer before erection.

17. **Stairs**

a) All stairs shall have not more than 13 risers in one flight but in case of fire escape stairs, 15 risers may be allowed instead of 13 risers. Height of risers and width of treads shall be180 mm (maximum) and 250 mm (minimum) respectively for fire escape stairs and 166mm (maximum) & 250mm (minimum) for general staircases. Minimum width of stairs shall be1000mm for fire escape stairs and 1200 mm for general stairs. In general rises shall be 150 mm.

b) Aluminium angle nosing shall be provided for edge protection of RCC stairs. Moulded marble nosing shall be provided for the main stairs finished with marble slab / Kota slab finishes.

c) 40ø NB stainless steel pipe handrail for stair in T.G. Hall area and 32ø NB medium class G.I pipe Handrail for stairs in other areas, minimum1.0 metre high, shall be provided around all floor/roof openings, projections/balconies, walkways platforms, concrete and steel stairs.1200mm high railing may be provided for external fire escape stairs. Handrail shall be two rail systems with the top rail 1000mm / 1200mm above the walkway/ platform/ floor surface and the intermediate rail 500mm below the top rail. Guardrail post spacing will be proportional to the length of the protected horizontal opening but will not exceed 1500mm c/c to posts. Stainless steel class shall be 304 grades.

18. Draining out water from floors

In all buildings, suitable floor drainage system to drain out water collected from equipment, blow downs, leakages, floor washings, fire fighting etc. Shall be provided in each floor.

19. **Fencing**

Minimum 3.0 metre high fencing above toe wall shall be provided around switch yard, trans-former yard, building transformer area, fuel oil area, Dry ash storage silo area & other areas where fencing is necessary due to statutory requirements. Fencing shall comprise 2.4 metre high PVC quoted galvanized chain link fencing of minimum 8 gauges (including PVC coating) of mesh size 75 mm and galvanized concertina for switch yard/transformer yard. Galvanized barbed wires of a height of 0.6 metres shall be provided above the chain link fence. The diameter of steel wire for chain link fencing excluding PVC coating shall not be less than 12 gauges. Steel entry gate matching construction shall be provided for all fenced areas. Top of the toe wall shall be minimum 200 mm above the formation level.

20. **Water Supply and Sanitation**

a) RCC roof water tank of adequate capacity depending on the number of users for 8 hours storage shall be provided for each building.

b) Galvanized MS Pipe of medium class shall be used for internal piping work for potable water supply.

c) Extra heavy cast iron pipes with lead joints or UPVC pipes with thermoplastic joints shall be used for sanitary work below ground.

d) UPVC pipes with proper sealing shall be used for sanitary work above ground level.

e) Each toilet shall contain following best quality fittings/porcelain fixtures in adequate numbers as per National Building Code. In toilets primarily meant for workers an additional squatting type WC shall be provided. Minimum one exclusive toilet facilities for handicapped shall be provided in each floor.

- Water closet – Indian & European type.
- Large flat back urinal with porcelain divider.
- Shower set.
- Wash basin – Counter-top wash basin to be provided in office areas selectively as per Owner's desire.
- Sink – Stainless steel sink with integrated drain-board to be provided in janitor's closets, kitchen, pantry areas of "FRANKE" or similar approved make.

- Metal storage cabinets, under- counter as well as overhead, shall be provided in janitor's room, kitchen, pantry and similar areas as per requirement of Owner.
- Minimum 600 mm long porcelain tray.
- Minimum 500 mm long stainless steel towel rail.
- Stainless steel liquid soap holder.
- Recessed porcelain soap tray in shower area.
- Stainless steel toilet paper roll holder.
- Robe hooks
- 450x750 mm high square edge 6 mm thick float glass mirror of adequate width to match toilet layout and interior décor.
- Septic tanks with up-flow filter including all accessories and extra heavy cast iron soil lines shall be provided.
- Effluent from septic tank shall pass through chlorination chamber to bring down BOD level to acceptable limit before discharging to nearest drain or to STP Main line.
- Drinking fountains in adequate numbers.

The exact number of fittings and fixtures, brand, colour etc. shall, however be finalized during detail engineering stage and same shall be of Owner's choice and Approval.

Note Toilets in Power House Operating Floor, Operating floor of service shall have coloured fixtures including counter-top wash basins with wide mirror, European type water closet with flush valve, sensor operated urinal, exclusive shower set etc. Other toilets in general shall have white porcelain fixtures, low down cisterns, sensor operated urinals etc. Toilets for handicapped persons shall have adequate grab bars, barrier-free access and appropriate fittings and fixtures.

Approved Make of toilet fixtures	:	KOHLER, Hindware, Parryware, Nycer, Cera.
Approved make of toilet fittings	:	KOHLER, Jaquar, ESCO, ESS ESS,.

21. **Under-Deck & Over-Deck Insulation**

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber
- Density of Material shall be between 40 to 60 Kg/m3
- Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m°K at an average temperature of 0°C
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990
- Material should be FM (Factory Mutual), USA approved.
- Water vapour permeability shall not exceed 0.017 Perm inch (2.48×10^{-14} Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor 'μ' value should be minimum 7000.

  Under-deck Insulation thickness shall be minimum 26mm for Kizen Project. Under-deck insulation shall be provided for all AC areas having roof exposed to sun.

Approved manufacturer- Armaflex, Kflex

For thermal over-deck insulation on the terrace BASF's PERIPOR board or similar shall be used. The insulation board shall have interlocking tongue-groove arrangement. The insulation board shall have the following specifications;

Colour: Orange

Thickness: 50 mm

Compressive strength: 200-220 kN/m2

Thermal Conductivity (K): 0.034 W/Mk

Thermal Transmittance (U): 0.5-0.6 W/m2 oC

Water Absorption (% vol): <0.1% (by total immersion)

Actual area covered would be used for measurement.

22. **Sealant**

1. Polysulphide Elastomeric joint sealant shall be, two-component, high performance polysulfide formulation equal or similar to MASTERFLEX 700i of BASF having weathering resistance to ultraviolet ray property. The product shall exhibit shore 'A' hardness of 25 and have movement accommodation factor of 25%. The sealant must comply with the performance specifications as laid in BS:4254 and ASTM C 920. All the joints must be primed using compatible primer for the substrate from the equal or similar to MASTERFLEX PRIMER range of BASF. Sealant application shall be carried out, strictly in accordance with Manufacturer's recommendations.

2. Polyurethane based single component joint sealant materials based upon polyurethane resins shall be similar or equal to Masterflex 472/474 of BASF. They have been formulated with different modulus of elasticity 0.25-0.45 N/mm2 and Shore 'A' hardness of 15-30 which makes them suitable for slightly different applications. The product shall exhibit elongation at break 600 % and recovery of 80%.

3. Bitumen sealing compound shall be conformed to IS:1834. Preformed bitumen impregnated fibre board conforming to IS:1838 shall be used as joint filler.

23. Approved make of other items

a)	Expansion Joint Control	3R Construction Solutions Pvt Ltd or similar
b)	Silicon Sealant	Dow Corning India Pvt. Ltd, McCoy Silicones Ltd. Or similar
c)	Insulation	TWIGA-for glass wool insulation, LLOYD, Mineral Rock Fibers Ltd.- for mineral fibre wool insulation. LLOYD for Rockwool insulation

		For extruded polystyrene foam insulation, "Insuboard" by The Supreme Industries Ltd BASF, TEXA or similar approved. For PU Insulation by BAYER India or similar approved.
	d) Toilet Partition:	Merino-Besco or equivalent.

24. **Statutory rules**

a) Design shall be complied with all applicable statutory rules pertaining to Factories Act as applicable for the State, Rules of Tariff Advisory Committee (TAC), and Water Act for pollution control etc.

b) Provision of safety, health and welfare according to Factories Act shall be complied with. These shall include provision of continuous walkway, minimum 500 mm wide, along the crane girder at crane girder level on both sides, comfortable approach to EOT crane cabin, fire escape, locker room for workmen, pantry, toilets, rest rooms etc.

c) Provision for fireproof doors, number of staircases, fire separation walls, encasing of structural members (in fire prone areas) etc. Shall be made according to the recommendation of Loss Prevention Association of India / Tariff Advisory Committee.

d) Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

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SECTION-XIX

TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

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SECTION-XIX

TECHNICAL SPECIFICATION FOR CARPENTRY AND JOINERY

1.00.00 SCOPE

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for in the schedule. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified in the “Schedule of Fixtures”.

2.00.00 INSTALLATION

2.01.00 Materials

a) **Timber**

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from decay, fungal growth, boxed heart, pitch pockets or steaks on the exposed edges, splits, large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenter’s work, the Tendered shall have the rough timber approved by the Engineer.

b) **Plywood**

Plywood boards are formed by gluing and pressing three or more layers of veneers with the grains of adjacent veneers running at right angles to each other. The veneers shall be either rotary cut or sliced and shall be sufficiently smooth to permit an even spread of glue. Face veneers may be either decorative on both sides or one side commercial and the other decorative. Ply wood shall be BWP grade or BWR grade as per IS 303. Plywood shall be commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde resin of B W R grade conforming to IS: 848.

c) **Decorative Laminated Plastic Sheets**

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

d) **Flush Doors**

Flush door shutters shall have a solid core with commercial or decorative or non-decorative (Paintable type as per IS 2202 Part I) faces and hardwood edges. The core for solid core doors shall be of block board or wood particleboard. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is phenol formaldehyde of BWR grade, conforming to IS: 848. The thickness shall be as specified in the "Schedule of Items". The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 percent when tested according to IS 1708.

Face Panel

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0mm and 3.0mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5mm for commercial veneers and between 0.4 mm and 1.0mm for decorative veneers, provided that the combined thickness of both is not less than 2.2mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

Lipping

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first class hardwood or as specified of depth not less than 25mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

Rebating

In the case of double leaves shutters the meeting of stiles shall be rebated by 8mm to 10mm. The rebating shall be either splayed or square type as shown in the drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

Opening for glazing

When required, glazing shall be provided and unless otherwise specified the opening for glazing shall be 250mm in height and 150mm or 200mm in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25mm. Opening for glazing shall be provided where specified or shown in the drawing.

Tolerance

Tolerance on the width and height shall be +3 mm and tolerance on nominal thickness shall be ± 1.2mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

Adhesive

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

e) **Panelled Glazed or Panelled and Glazed Shutters**

Panel door shall be of teakwood shutter frame unless otherwise noted and panels with teakwood/commercial ply/teakwood particleboard as per “Schedule of Items” and as per drawing or as recommended and approved by Engineer in charge.

Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fiber board wire gauze or float glass. The shutters may be single or multipanelled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for frame work, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any wrap or bow and shall have smooth well planed face at right angles to each other.

Other considerations shall be as mentioned in item (d) above.

Window and Ventilator Shutters

Window and Ventilator shutters shall conform to IS 1003 (Part 2)

f) **Laminated Veneer Lumber (LVL)**

Laminated Veneer Lumber door frames and shutters shall conform to IS 14616

Material

i) **Laminated Veneer Lumber (LVL)**

Laminated Veneer Lumber is made of rubber wood silver oak, eucalyptus, Poplars, acacias etc. veneers glued tighter having grains of all the veneers in one direction under high temperature and pressure to develop high Modulus of Rapture & Modulus of elasticity. Veneers for LVL shall be of thickness between 1.5 to 2.5mm.

ii) Veneers shall be free from knot holes, decayed knots except pin knots, unfilled splits wider than 3 mm, concentrated borer holes, shakes, objectionable decay or termite attack, except that for the face veneers none of these defects or cross grain exceeding 1 in 10 shall be permitted. The nominal thickness of all the veneers used shall be identical and uniform within a tolerance of ± 5 percent.

iii) **Adhesives :** Only BWP grade adhesive conforming to IS 848 shall be used for making LVL.

iv) **Preservatives :** Veneers used for LVL shall be given preservative treatment before lamination, with a preservative that is compatible with the adhesive to be used. Only fixed type of water soluble preservatives, CCA or CCB, or non-leachable, solvent soluble preservatives as per IS 401 shall be used for treating the veneers. Retentions of preservatives shall be as per IS 401 depending upon the proposed end use.

All the Veneers shall be given preservative treatment by one of the water soluble fixed type treatment, Copper Chrome-Boron Composition. (CCB) as per IS 401. The treated Veneers shall than be dried having moisture content less than 6%. The Veneers shall be glued together, by keeping all the grains in one direction, with BWP grade synthetic resin adhesive conforming to IS 848. The Veneers having moisture content less than 6% so glued, shall be pressed in hot press at high temperature of 140 degree C to 180 degree C. and pressure 1.4 to 1.8 MPa. The net absorption of preservative in LVL when tested as per IS 2753 shall not be less than 8.0 kg/m^3 Veneers shall be scarf joined only length wise and not in the direction of width with EWP type synthetic resin adhesive. However, the length of individual Veneer shall not be less than 600mm.

Moisture Content

The average moisture content of three test specimens, when determined in accordance with IS 1734 (Part 1) shall be between 5 to 15%.

g) **Laminated Veneer Lumber (LVL) Door Shutters**

This specification lays down requirements regarding types, sizes, material, construction, workmanship and finish, performance evaluation, sampling, measurements, rates and testing of Laminated Veneer Lumber (LVL) door shutter for use in domestic buildings, offices, schools, hospitals, etc. This specification does not cover large size door shutters for industrial and special buildings such as workshops, garages, godowns etc.

The material of each lot shall be supported by a certificate to that effect:

Each lot of LVL materials shall be accompanied by the test reports. Fabricated shall take up manufacturing of shutters only if provisions of clause mentioned above fulfilled, failing which, shutters so manufactured are liable for rejection.

Panelling Materials

Plain Particle Board : Plain particle boards used for panels shall be FPT-1 conforming to IS 3087 and shall have been bonded with BWP type of synthetic resin adhesive as per IS 848.

Pre-laminated Particle Board : Pre-laminated particle boards used for panels shall conform to IS 12823. The plain particle boards used in pre-laminated particle boards shall be as per stated above.

Medium Density Fiber Board : Medium density fibre board used for panels shall confirm to exterior grade as per IS 12406 made from agro-forest products or agricultural wastes or natural fibers.

Pre-laminated Medium Density Fiber Board : Pre-lamination in pre-laminate medium density fiber board shall confirm to the requirements such as Abrasion Resistance, Resistance to Steam, Crack Resistance, Resistance to Cigarette Burn and Resistance to Stain as specified in IS 12823. The medium density fiber board used in pre-laminated medium density fiber board shall be as per stated above.

Glass: Glass for glazing shall confirm to IS 2835 or IS 2553. The use of other types of glass, such as frosted glass, wired glass may also be specified by the Engineer-in-Charge.

Wire Gauze : Wire gauze shall generally confirm to IS 1568 and shall be regularly woven with equally spaced galvanized mild steel wires of 0.63 mm nominal diameter in both warp and weft directions to form aperture of average width 1.40 mm.

h) **Construction and Workmanship**

Laminated Veneer Lumber (LVL) paneled, glazed and panelled and glazed shutter shall be constructed in he form of LVL framework of stiles and rails with panel inserted conforming (as per stated above) of plain or perlaminated particle board, plain or perlaminated medium density fibre board, wire gauze or glass. The panels shall be fixed by either providing grooves in stiles and rails and beadind as specified. The stiles top rails, lock rails and bottom rails shall be jointed to each other by mortice and tenon joints. Rails having width of 150 mm or more shall have plain double tenon joints. Other rails shall have single tenon joints. The bottom lock and top rails shall be inserted 25+3 mm short of the width of stiles to form a stub mortice & tenon joint. After assembling shutters complete with panels, Bamboo pins of 6 mm dia shall be fitted on each tenon and mortice joint by drilling suitable size of holes (2 pins per joint for rail width upto 150 mm and 3 pins for rails of greater width). All the four edges of shutter shall be beaded with 12 mm thick rubberwood /plantation wood lipping. Lipping shall be seasoned and chemically treated. Lipping on top and bottom rails shall be of one piece and lipping on stiles may be in two pieces. All lippings shall be glued to shutter with water resisting glue (Synthetic rubber passed adhesive) at the rate of 0.15 kg/m^2.

All members of the shutters shall be straight, smooth and with well planed faces at right angles to each other. Any wrap and bow shall not exceed 1.5 mm. The right angle for the shutters shall be checked by measuring the two diagonals from one extreme corner to the opposite one and the difference between the two diagonals shall not be more than 3 mm.

Beading : All the panels except glass and wire gauze shall be fixed with grooves but additional beading may be provided either on one side or on both the sides, if so specified. In so far as glass and wire gauze panels are concerned, beading shall be provided without grooves. In such a case where beading is provided without the grooves, the beading shall be only on one side, the other side being supported by rebate from stiles. The beading shall have a size not less than 15 mm x 10 mm. It can be fixed by suitable handless nailing or screwing. The beading shall be of plantation timber section, preservative chemically treated of fixed type as per IS 401–1982.

Stiles, top rails, bottom rails and lock rails of shutters shall each be made in one piece of LVL, only.

Muliions and glazing bars shall be stubtenoned to the maximum depth which the size of the member wood permit or to a depth of 25 mm, whichever is less.

The minimum depth of grooves of stiles and rails shall be 12 mm for all types of panelling. The panels shall be framed into grooves to the full depth of groove leaving an air space of 1.5 mm and the faces shall be closely fitted to the sides of the groove.

LVL shutters shall be manufactured in factories under controlled conditions.

i) **Panelling**

Plain and perlaminated Particle Board Panelling : The panels shall be made of one piece of plain or prelaminated particle board of thickness 12 mm or more.

Wire Gauze Panelling : Wire gauze panel shall be so designed that no single panel shall exceed 0.5 sqm. in area.

j) **Rebating**

In case of double leaved shutters, the meeting of the stiles shall be rebated either splayed or squire type as per IS 1003 (part-1).

k) **Gluing of Joints**

The contact surfaces of tenon and mortice shall be treated before putting together as per IS 1003 (part-1). All the tenon and mortice joints should be glued together and pinned to full thickness of the door with Bamboo pins.

l) **Tolerances**

Tolerance on the size of door shutter shall be +3 mm and in thickness +1.2 mm.

m) **Location of Fittings and Accessories**

Each door shutter shall be fixed to the frame with four hinges, unless otherwise specified by the Engineer-in-Charge, of the type specified.

The lock rail of door shutters, where provided, shall be so placed that its centre line is at a height 850+5 mm from the bottom of the shutter. Hinges and other fixtures shall be fixed to shutter with full threaded steel screws after coating the screws with adhesive such as fevicol etc. For fixing of hinges, holes of 3.5 mm diameter and 52 mm length shall be bored and No. 10 full threaded parallel shank steel screws, 50

mm long, coated with adhesive shall be used. In no circumstances screws shall be hammered into board.

Cleats and blocks made of LVL wood shall be fixed to door shutter, if required, by the user as per size and shape approved. Pull bolt or sliding door bolt etc. shall be provided in the door shutter at a height of 850 mm from bottom of shutter. These shall be fixed to shutter as per method of fixing described above.

For rescrewing, a plastic sleeve of appropriate diameter shall be inserted into the hole and then fixing with full threaded screws shall be done. Fittings other than hinges shall be provided as per scheduled by the user. The fittings shall conform to specifications as described above.

Panelled shutter may be provided with louvers of vision panels as specified. Where such a provision is made, the position, size and shape of louver or vision panel opening shall be as specified.

n) **Finish**

All the four edges of the shutter shall be squire. The shutter shall be free from twist or warp in its plane. Panels of the door shutters shall be flat and well sanded to a smooth and level surface. All the surfaces shall be delivered without protective coat of wood primer polish or varnish.

o) **Glazing**

Glazing in the shutters of door and window shall be as per in specifying sizes of the openings or panels of glass, the first dimension shall be width. The glass shall be embedded in putty and secured to the rebate by the wooden beading of suitable size and shape.

p) **Fixtures**

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing or specified in the “Schedule of Fixtures”. However minimum number of fixtures shall be as follows :

1. **For external single leaf door :**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge
- 10mm dia & 300mm long SS tower bolt on inside face.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.

- Heavy duty automatic door closer.
- Rain drip

2. **For external double leaf door :**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge on both shutters.
- 10mm dia & 300mm long SS tower bolt on inside face on both shutters.
- Mortise lock & latch either barrel type or rectangular type.
- SS doorknob or handle on both faces.
- SS Door stopper with EPDM stay piece.
- Heavy duty automatic door closer on active shutter.
- Rain drip

3. **For external single leaf window :**

- 6Nos hold fast or anchor bolts.
- 3Nos 100mm long SS hinge
- 10mm dia & 300mm long SS tower bolt on inside face.
- SS pull ring minimum 6mm thick and 50~75mm dia.
- SS window stay piece.

2.02.00 **Partitions**

These shall be conform to drawings an all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

a) **Materials**

Gypsum Board conforming to IS 2095 (Part-1)

Non asbestos multi-purpose cement board conforming to IS 14862
Tapered edge calcium silicate board

Tapered Edge Calcium Silicate Board is manufactured from Siliceous and Calcareous materials reinforced with fibers. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminium or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

b) **Installation**

The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of Engineer-in-Charge.

c) **Jointing & Finishing**

Joints of the boards are finished with specially formulated joining compounding and fiber tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hard laminates. Services should be incorporated before commencement of board fixing.

d) **Fitting and Fixtures**

It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement of board fixing.

e) **Tolerance**

Tolerance in dimensions shall be ± 5 mm.

2.03.00 **UPVC-Door Frames**

a) **Material**

Polyvinyl chloride Resin suspension grade is the basic raw material for forming PVC compound. PVC resin then is mixed with chemicals like Calcium, Stearate, Hydrocarbon Wax, Titanium Dioxide, Calcium Carbonate, Acrylic processing aids. Further, additives like impact modifiers, pigments, epoxy plasticizer, UV stabilizer, lubricants, chemical blowing agent etc. are added. The purpose of adding the chemicals and additives is to impart cellular structure, strength, surface finish, colour and resistance to fading by light rays. These chemicals are mixed in the desied proportion and shall be used in the formulation of PVC material and for free and smooth extrusion of PVC profiles.

b) **UPVC Door Frame**

UPVC door fame shall be made of PVC material conforming to IS 10151. The door frame shall be made from extrude UPVC section having overall dimensions of 48 x 40 mm or 42 x 50 mm having wall thickness of 2.0 mm ± 0.2 mm. Corners of the door frame to be jointed by M.S. galvanized brackets. Joints mitred and plastic welded. The hinge side vertical outer frames shall be reinforced by galvanized M.S. Tube of size 19 x 19 mm of wall thickness 1 mm ± 0.1 mm and a tie rod shall be provided at the bottom of the frame. The frame shall be fabricated in factory as per nomenclature of the item and directions of Engineer-in-Charge.

c) **Fixing of Frames**

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The fames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the fames are to be fitted, a 50 mm strip should be left untiled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the centre. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

2.04.00 **PVC Door Shutters**

The shutters shall be fabricated at factory as per nomenclature of the item and directions of Engineer-in-Charge. Shutter shall be made of PVC material conforming to IS 10151.

24 mm thick PVC Door Shutter
30 mm Thick PVC Door Shutter
Sampling and Criteria for Conformity

a) **General Precautions**

The test specimens shall not have been exposed to a temperature below 400C for 24 hours immediately preceding the test and shall be free from all / visible moisture. The specimen shall be inspected and any specimen with visible flaws shall be discarded.

If the test specimen fails because of mechanical reason, such as failure of testing equipment or improper specimen preparation, it shall be discarded and another specimen taken.

b) **Sampling**

Sampling criteria for conformity shall be in accordance with IS 4020 (Part-I)

Lot in any Consignment of shutters shall be of the same grade and type and manufactured under similar conditions of production which shall be grouped together to from a lot.

The number of shutters to be selected at random from a lot shall depend upon its size.

c) **Fixing of Shutters**

PVC door shutters shall be side hung on three bolt hinges of size 100 mm, one at the centre and the other two at 200 mm from the top and bottom of the shutter. The flat of the hinges shall be neatly counter sunk in to the recesses cut out to the exact dimensions of the hinge flap. The door shall be drilled on the thickness to fit hinges. Screws for fixing the hinges shall be screwed in with screwdrivers and not hammered. The length of the screws should be 8 mm / 30 mm. The hinges used should be of stainless steel.

d) **Tolerance**

The tolerance on the width and the height of the door shall be ± 5 mm and the tolerance on the nominal thickness of the door shall be ± 2 mm.

e) **Fittings**

Fittings shall be provided as per scheduled of fittings decided by Engineer-in-Charge. In moisture prone areas M.S fittings and screws should not be used. Hardware such as handles, tower bolt, stopper, buffer etc. should be directly screwed (not pre-drilled) and fitted on the door.

2.04.00 **PVC Door Frame**

Solid PVC Door Frames consisting of section 50 x 47 mm shall be fabricated from 5 mm PVC sheet having density of 600 kg./cum. The sheet used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The weight per running metre of the door frame including reinforcement should be a minium of 1.5 kg./sqm. The depth of the rebate of door frame shall be 10 mm. Frames shall have smooth surface, without any warping or bending in any member. All the parts of the door frame are to be jointed to each other using solvent adhesive conforming to IS 14182. A tolerance of ± 3 mm. shall be permitted in the specified dimension of PVC section in the door frames.

The solid PVC door frames shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-Charge.

Fixing of Frames : As stated earlier

2.04.00 **Panel PVC Door Shutter**

Panel PVC Shutters are factory made shutter and shall be brought to site fully assembled. The Solid Panel PVC Door shall be fabricated from 5 mm PVC sheet. The sheets used may be in plain colour, printed design or prelam veneer shade as approved by the Engineer-in-Charge. The shutters shall be fabricated at factory as per nomenclature of the item and directions of the Engineer-in-Charge.

a) 30 mm thick panel PVC door shutters.

2.05.00 **Fibre Glass Reinforced Plastic (FRP) Door Frames**

Door frames shall be three legged of cross section 90 mm x 45 mm having single rebate of size 32 mm x 15 mm to receive shutter of 30 mm thickness. The frame shall be made of laminate of thickness of 2 mm and shall be filled with wooden blocks of exterior grade MDF or seasoned and treated hard wood inside the laminate in all the three legs of the frame. The frame to be moulded by either hand lay up to resin transfer moulding process. The process shall consist of laying gelcoat at 1000 gms./sqm. and laid over with layer of FRP Mat (CSM mat) gelcoat and FRP (CSM Mat) are defined in IS 14856. The CSM mat shall be bonded with Isophatholic resin in the ratio not less than 1:2 (One part of Mat to two parts of Isopathlic resin and fillers & additives) by weight. The edge shall be sealed with gelcoat and FRP mat to obtain smooth finish. Sufficient roving shall be laid in the corner to have smooth curve while laying the CSM mat.

a) FRP door shall be manufactured as per specifications laid down in IS 14856, nomenclature of items & direction of Engineer-in-Charge.

b) **Tolerance :** Tolerance of size of frame to be ± 2 mm. and on size of rebate to be +1 mm.

c) **Finish :** The surface of the moulded frame shall be free from any visible defects such as small pores, crazing, blistering, wrinkling, impurities, defective impregration, colour bolts and aggregate defects, as mentioned in IS 14856. Scattered pin holes duly repaired and finished by applying resin and not noticeable shall be acceptable. Frame laminate shall be flat and shall have smooth and level surface. Laminate shall be finished in colour and shade as approved by Engineer-in-Charge.

d) **Fixing of Frame :** As stated earlier.

2.06.00 **Fibre Glass Reinforced Plastic (F.R.P.) Shutters**

a) F.R.P. Shutters shall be manufactured conforming to the specifications as per IS 14856 and nomenclature of item & direction of Engineer-in-Charge.

b) Blocks of any seasoned hard wood of bulk density not less than 450 kg / cum At 12 per cent moisture content or any other material of sufficient thickness and length shall be provided inside the shutter at suitable place to hold fittings and fixtures such as aldrops, tower bolt, handle, sliding door bolt, mortice lock etc. Blocks for hinges shall be provided at three locations, unless otherwise specified by the purchaser. One at the centre and other two at 200 mm from the top and the bottom of the shutter. Blocks shall be provided at predetermined places in the shutter so as to fix hinges mortice locks, tower bolts, aldrops, door closures, etc. The finished surface shall be buffed and polished with wax.

c) **Location of Fittings and Accessories :** The lock rail of door shutters shall be so placed that is centre line is at a height 850 + 5 mm from the bottom of the shutter. Door shutter shall be fixed to the frame with three hinges, unless otherwise specified by the purchaser, of the type specified. These locations shall be, one at centre and other two at 200 mm from the top and the bottom of the shutter, where blocks have already been provided and suitable location by depressing the profile has been made. Screws for fixing the hinges shall be screwed in with screwdrivers & not hammered. The length of screw should be 8/30 mm. The hinges used shall be stainless steel or aluminium.

d) **Sampling & Criteria for conformity :** As stated earlier

e) **Finish :** Stated earlier

f) **Fixing of Shutter :** Stated earlier

g) **Tolerance:** Stated earlier

2.07.00 **Solid PVC Fome Profile Doors**

a) **Solid PVC Foam Profile Frame**

Solid PVC foam profile frame doors are made from solid PVC foam profiles 60 x 30 mm with integral skin cut to required size. Doors are provided with naturally strong stiffener frame and sandwich panelled to offer sound and heat insulation with pressure laminate/infill panel to provide scratch resistance surface. The frame shall be fabricated in factory as per nomenclature of the item and directions of the Engineer-in-Charge. PVC door frame should have shore hardness more than 70.

b) **Fixing of Frames:** Stated earlier

2.08.00 **Solid PVC Foam Shutters**

Solid PVC foam shutters are made from solid PVC foam profiles with integral skin. Door are provided with naturally strong stiffener frame and sandwich paneled to offer sound and heat insulation with pressure laminate/infill panel provides scratch resistance surface. Door shutters can be nailed, screwed, drilled, glued, sawn lapped or welded just like wood and characterized by excellent screw holding strength (200 kgf.).

a) **28 mm Thick Door Shutters**

Profile is cut in required length to make vertical & horizontal site. Mitered cut joint are made using solvent based PVC adhesive & epoxy solvent. GI 'C' stiffener 39 x 19 x 19 or 40 x 20 x 19g. M.S. Pipe is fixed in the grooves made in frame. Telescopic polymeric corners are provided at corners are provided at corners for better rigidity. Infill panel 3 mm thick HPL sheet is fixed with is fixed with csk screws of required size to the profile frame as specified. Mirror image of shutter frame is jointed using solvent based PVC adhesive as well as csk type sheet metal screws of required size at four corners at top & bottom. Additional bonding strength is provided by using silicon sealant epoxy sealant at joints. Lock rail is provided by using PVC profile & 'C' type GI stiffener 40 x 10 in the groove & fixed with adhesive to frame & infill. Decorative corner moulding is fixed to impart elegant look.

The fabrication shall be done in done in factor as per nomenclature of the item and directions of Engineer-in-Charge.

b) **Sampling and Criteria for conformity :** Stated above

c) **Fixing of Shutters:** Stated above

d) **Tolerance:** Stated above

e) **Fittings:** Stated above

2.09.00 **Factory Made Fibre Glass Reinforced Plastic Chajja**

F.R.P. chajja shall be 4 mm thick of required colour/size, design and drawing as approved. The chaja shall have smooth gradual slope curvature for easy drainage of water & shall be factory manufactured as per nomenclature of item & directions of Engineer-in-Charge.

Material

1) Glass Fibre (chopped strand mat) shall be as per IS 11551
2) Unsaturated Polyester Resin shall be as per IS 6746
3) Surface Burning Characteristics of Building Material – ASTM E84-77a
4) Unsaturated Polyester Resin Gel coat shall be as per IS 6746
5) Curing Agents – Cobalt Napthanate and MEKP
6) Test of Products – IS 14425
7) Glass Fiber Roving – IS 11320

The F.R.P. chajja laminate shall be water and chemical resistant and shall have very high transit strength to weight ratio and high modules of elasticity, good textile processing and excellent fiver reinforcement properties. The laminate shall have low coefficient of thermal expansion and a high thermal conductivity and high dielectric constants. The F.R.P. laminate shall be diversionally stable, shall have moisture and corrosion resistance.

Tolerance

Tolerance of ± 10 mm in overall size of FRP chajja is permissible.

2.10.00 **Workmanship**

2.10.01 **General**

Skilled carpenters as per details shown on drawing or instructed by the Engineer shall do the work.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. that will come in contact with masonry after fixing shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particleboard. The edge of all plywood, block board and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long MS holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M. S. grills or guard bars shall be provided to windows where called for in the drawings or schedule of items.

2.10.02 **Finish**

All carpentry work after finishing shall be sand papered smooth. Prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.10.03 **Surface Treatment**

When shown on drawings or called for in Schedule, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 **ACCEPTANCE CRITERIA**

3.01.00 **Door and Window Frames**

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 **Door and Window Shutters**

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 **Pelmets, Furniture, etc.**

3.03.01 **General**

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 **Pelmets**

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.03 **Cupboard Shutters**

Shall operate smoothly without jamming and locks, holding chains, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.04 **Drawers**

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.05 **Loose Furniture**

When placed on level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 **RATES**

Rates shall be unit rates including preservatives, shop coats, primers varnishing, polishing etc. against items mentioned in Schedule. No separate payment will be made for fixing caulking etc. unless separately provided for in Schedule.

5.00.00 **METHOD OF MEASUREMENT**

5.01.00 **Door and Window Frames, Handrails etc.**

Woodwork in frames handrails etc. shall be measured for the volume of timber used, i.e. the minimum theoretical rectangular section from which the shape can be obtained multiplied by the length of timber required. In computing the length, timber required for tennons, scarves, embedding to walls over the finished length shall be added. Mitred pieces shall be measured along the longest length.

5.02.00 **Holdfasts**

Shall be measured for actual number used.

5.03.00 **Door and Window Shutters**

Shall be measured for actual outer area of shutters for different thickness and types described in Schedule.

5.04.00 **Glass and Glazing**

Shall be measured and paid separately under relevant items.

5.05.00 **Fittings and Fixtures**

Shall be measured separately in actual numbers used for different sizes and types described in Schedule.

5.06.00 **M S Grills and Guard Bars**

Shall be measured and paid separately under relevant items.

5.07.00 **Partitions, Paneling, etc.**

Shall be measured for actual area excluding door shutters. Door shutters shall be measured and paid separately under relevant items.

5.08.00 **Pelmet, Shelves, etc.**

Shelves shall be measured for actual area of finished surface. Pelmets shall be measured for length of different types enumerated in the Schedule.

5.09.00 **Furniture**

Shall be measured for actual number of each type.

6.00.00 **IS CODES**

Some of the important relevant Codes for the Sections are:

IS : 4021	-	Timber door, window and ventilator frames
IS : 1003	-	Timber paneled and glazed shutters.
IS : 2191	-	Wooden flush door shutter (Cellular and hollow core type)
IS : 2202	-	Wooden flush door shutters (Solid core type)

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SECTION-V

TECHNICAL SPECIFICATION
FOR
CEMENT CONCRETE [PLAIN & REINFORCED]

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SECTION-V

TECHNICAL SPECIFICATION FOR CEMENT CONCRETE [PLAIN & REINFORCED]

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.02.00 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in SCOPE of IS:456.

1.03.00 IS:456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specifications and/or replacement by any International Code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided by the Contractor, unless otherwise specified shall include but not be limited to the following :

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Except where it is excluded from the Scope of Contract, Contractor shall prepare progressively and submit for approval of detailed drawings and Bar Bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval.

d) Submit for approval of shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Submit for approval of detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

f) Submit for approval of detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval of concrete mix designs required to be adopted on the job.

h) Furnish samples and submit for approval of results of tests of various properties of the following:

   i) The various ingredients of concrete

   ii) Concrete

   iii) Embedments

   iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings, specifications and Schedule of Items.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved proforma for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 **Work by Others**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 **Information to be submitted by the Tenderer**

2.03.01 **With Tender**

The following technical information are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms, if any, with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 **After Award**

The following information and data including samples, where necessary, shall be submitted by the Contractor progressively during execution of the contract.

a) **Programme of Execution and Requirement of Materials**

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work giving month-wise requirements of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms and conditions of the Contract. In case the Contractor proposes to take on hire any machineries or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Contractor before the end of the previous month.

b) **Samples**

Samples of the following materials and any other materials, proposed to be used, shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates.

ii) Admixtures.

iii) Plywood for Formwork.

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other waterproofing materials.

vi) Joint filling compounds.

vii) Foundation quality Rubber Pads.

c) **Design Mix**

Design mix as per Clauses 2.1 (g) & 3.4 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S. Codes, is to be submitted to the Engineer for his approval before it can be used on the works.

d) **Detail Drawings and Bar Bending Schedules**

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.1(b) and 3.16.1 of this specification.

e) **Detailed Drawings and Designs of Formworks to be used**

Detailed design data and drawings of formworks to be used as per clause 2.1 (c).

f) **Detailed Drawings for Templates & Temporary Supports for Embedments**

As per Clause 2.1 (e).

g) **Mill Test Reports for Cement & Reinforcing Steel**

Mill Test Reports for Cement and Reinforcing Steel in case these materials are supplied by the Contractor.

h) **Inspection Reports**

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer in accordance with Clause 2.4 of this specification.

i) **Test Reports**

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification.

j) Any other data which may be required as per this specification.

2.04.00 **Conformity with Design**

The Contractor will prepare check lists in approved proforma which will be called 'Pour Cards'. These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Engineer will give written permission on the same 'Pour Card' allowing the Contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', will be prepared by the Contractor on approved proforma. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 **Materials to be used**

2.05.01 **General Requirement**

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

2.05.02 **Cement**

Generally the following type of cement shall be used with prior approval of the Engineer :

a) 43 Grade Ordinary Portland Cement conforming to IS: 8112

b) 53 Grade Ordinary Portland Cement conforming to IS: 12269

c) Portland Slag Cement conforming to IS: 455

d) Portland Pozzolana Cement (fly ash based, by intergrinding Portland Clinker) conforming to IS:1489 (Part-1)

e) Portland Pozzolana Cement (calcined clay based) as per IS: 1489 (Part-2)

In special cases, the following types of cement may be required to be used with prior approval by the Engineer:

a) Rapid hardening Portland Cement conforming to IS: 8041

b) Hydrophobic Cement conforming to IS: 8043

c) Low heat Portland Cement conforming to IS: 12600

d) Sulphate Resisting Portland Cement conforming to IS: 12330

N.B.: Blending of Fly Ash with Ordinary Portland Cement at site is not allowed.

2.05.03 **Aggregates**

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious materials. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

a) **Coarse Aggregate**

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS: 383 will be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary.

The grading of coarse aggregates by sieve analysis shall be as per IS: 383.

b) **Fine Aggregate**

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 will be termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

In certain cases there may be two types of sand , one very fine and the other very coarse. In such cases, the two types shall be combined to meet the requirements of a particular zone of IS: 383. In most cases, the preferred zone is Zone - II.

In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading.

Crushed stone sand alone may be used only with the approval of the Engineer. However, percentage passing through 150 micron and 75 micron shall not exceed 15% and 10% respectively for crushed stone sand.

2.05.04 **Water**

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS: 3550 will be followed for routine tests. Acceptance test for water shall be as per IS: 3025, and Table - 1 of IS: 456.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS: 516 & IS: 4031 respectively. The PH value of water shall generally be not less than 6.

2.05.05 **Admixture**

Only admixture of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards:

IS: 2645 - Integral cement water proofing compound

IS: 9103 - Indian standard specification for Admixtures for Concrete

Or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075, Part 1 to 3) and may be one of the following:

a) **Accelerating admixtures**

- Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10" or approved equivalent.

b) **Retarding admixtures**

- Modified lignosulphonate based set retarding concrete admixture like "Plastiment R" or approved equivalent.

c) **Water reducing admixtures**

- Modified sulphonated melamine formaldehyde based water reducing concrete admixture like "Sikament" or approved equivalent.

d) **Air entraining admixtures**

- Modified lignosulphonate based air entraining concrete admixture like “FLOMO AEP " or surface active agents like "Sika AER" or approved equivalent.

e) **Water proofing admixtures**

- Modified lignosulphonate based waterproofing admixture like "Plastocrete Super" or approved equivalent.

However, the Contractor shall furnish following technical information about the admixtures (alongwith the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer:

i) Type of admixture

ii) Mix proportion & mode of application in concrete/mortar

iii) Manufacturer’s specification & necessary quality assurance certificates (mainly on chloride & sulphate content, PH value, infra red analysis & solid content).

2.05.06 **Reinforcement**

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/ Drawing/ Instructions. All bars shall be of tested quality.

2.06.00 **Storage of Materials**

2.06.01 **General**

All materials shall be so stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain up-to-date accounts of receipt, issue and balance (stack-wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 **Cement**

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well ventilated ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

Different types of cement shall be clearly marked with the type & different types of cement shall not be intermixed.

2.06.03 **Aggregates**

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk- heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 **Reinforcement**

Reinforcing steel shall be stored consignment wise and size wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 **Quality Control**

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture : Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete

For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits

b) Aggregate : Physical, chemical and mineralogical qualities. Tests for grading, moisture content and impurities.

c) Water : Impurities tests.

d)	Cement	:	Tests to satisfy relevant IS Specifications (If Contractor's supply).
e)	Formwork	:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f)	Reinforcement	:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices. Material tests or certificates to satisfy relevant IS Specification (If Contractor's supply).
g)	Grades of concrete	:	Usage and mix design, testing of all properties.
h)	Batching & Mixing	:	Types and capacity of plant, concrete mixers and transportation equipment.
i)	Joints	:	Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
j)	Embedded & Anchorage Items	:	Material, shape, location, setting.
k)	Placing	:	Preparation, rate of pouring, their limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
l)	Compaction	:	Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
m)	Setting of base & Beaming plates	:	Lines, elevations and bedding mortar.
n)	Concrete Finishes	:	Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
o)	Curing	:	Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirts or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

However, all washing & screening of aggregates shall be carried out by approved means as approved by the engineer to ensure compliance with the aggregate specification.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures may be permitted to be used in accordance with IS: 456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in any of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing or as per the Engineer's instructions. In case of liquid retaining structures, IS: 3370 will be followed.

3.04.00 Proportioning and Works Control

3.04.01 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer.

a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.

b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS: 456 may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 **Mix Design Criteria**

Concrete mixes will be designed by the Contractor to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations:

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.

e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete adopted in design and specified on drawings by the Engineer. The Contractor will strictly abide by the same in his design of concrete mix installation.

Notwithstanding anything mentioned in various tables given in IS: 456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, the following tables are included in the specification. For identical condition if values given in the tables shown herein below are different from those mentioned in IS: 456, the values as indicated in the table shown herein below shall prevail.

Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE – I

STRENGTH REQUIREMENT OF CONCRETE

Grade Designation	Specified Characteristic Compressive strength of 150 mm Cube at 28 days **(All values in N/Sq.mm)**
M 10	10
M 15	15
M 20	20
M 25	25
M 30	30
M 35	35
M 40	40

Note - 1 : Nominal mix concrete of proportions M7.5 or M10 may be used as lean concrete for simple foundations for masonry walls, below the reinforced concrete foundations and mass filling.

Note - 2 : Grades of concrete lower than M20 shall not be used in reinforced concrete.

TABLE - II
MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO
(FOR GUIDANCE)
CEMENT/TOTAL AGGREGATE RATIOS

WORKABILITY	WATER/ CEMENT RATIO	RATIO BY WEIGHT OF CEMENT TO GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT TO CRUSHED STONE AGGREGATE	
		20 mm Size	38 mm size	20 mm size	38 mm size
Very low Slump 0-25 mm	0.4	1:4.8	1:5.3	1:4.5	1:5.0
	0.5	1:7.2	1:7.7	1:6.5	1:7.4
	0.6	1:9.4	1:10	1:7.8	1:9.6
	0.7	1:10	1:12	1:8.7	1:10.6
Low Slump 25-50 mm	0.4	1:3.9	1:4.5	1:3.5	1:4.0
	0.5	1:5.5	1:6.7	1:5.0	1:5.5
	0.6	1:6.8	1:7.4	1:6.3	1:7.0
	0.7	1:8.0	1:8.5	1:7.4	1:8.0
Medium Slump 50-100 mm	0.4	1:3.5	1:3.8	1:3.1	1:3.6
	0.5	1:4.8	1:5.7	1:4.2	1:5.0
	0.6	1:6.0	1:7.3	1:5.2	1:6.2
High Slump 100-150 mm	0.4	1:3.2	1:3.5	1:2.9	1:3.3
	0.5	1:4.4	1:5.2	1:3.9	1:4.6
	0.6	1:5.4	1:6.7	1:4.7	1:5.7
	0.7	1:6.2	1:7.4	1:5.5	1:6.5

Note - 1 : Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

Note - 2 : It should be noted that such high aggregate cement ratios will be required or concretes of very low slump and high water-cement ratios which may be required to be used in mass concrete work only.

Note - 3 : The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.05.00 **Strength Requirements**

The strength requirements of both design mix and nominal mix concrete where Ordinary Portland Cement or Portland Slag Cement is used shall be as per Table-2 of IS: 456. All other relevant clauses of IS: 456 shall also apply.

3.06.00 **Minimum Cement Content**

The minimum cement content recommended for each grade of concrete will be as shown below as per Table 5 of IS: 456.

TABLE - III

MINIMUM CEMENT CONTENT SPECIFIED FOR DIFFERENT GRADES OF CONCRETE

Grade of Concrete	Minimum Cement Content/Cu.M of Finished Concrete
M 15	Kg 240
M 20	Kg 300
M 25	Kg 300
M 30	Kg 320
M 35	Kg 340
M 40	Kg 360

The minimum cement contents mentioned above are for average conditions and for 20 mm size aggregate. For 40 mm size aggregate the cement content may be reduced (Refer Table 6 of IS: 456).

In case the cement content can be reduced due to continuous and consistent favourable conditions, on account of better quality of cement or by the addition of suitable plasticizer / super plasticizers, then the Engineer may instruct lower cement content, and the Contractor shall abide by the stipulations laid down hereunder:

a) The Contractor shall design the mixes for 10% (Ten per cent) higher strength over and above those specified in Table - I under Clause 3.4, for the various grades of concrete and different slump requirements.

b) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

c) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.

d) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

In case there is a downward revision of the minimum cement content from that specified in the contract, the particular unit rate of concrete will be reduced by an amount equal to the cost of cement saved, calculated at the issue rate. The relevant cost of wastage and handling on the cement saved, which is inherent in the total cost of structure, will not be deducted from the unit rate and will thus pass on to the Contractor.

3.07.00 **Water Cement Ratio**

The choice of water cement ratio in designing a concrete mix will depend on

a) The requirement of strength.

b) The requirement of durability.

3.07.01 **Strength Requirement**

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS: 456 will be selected by trial and error. The values of water- cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-9 of IS: 456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS: 456.

3.07.02 **Durability Requirement**

Tables 3, 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

The water cement ratio between 0.4 and 0.45 is generally found desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer / super- plasticizer. However the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use Melamine based plasticizer.

3.08.00 **Workability**

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE - IV

LIMITS OF CONSISTENCY

Degree of Workability	Slump in mm with Standard Cone as per IS: 1199		Use for which concrete is suitable
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads and like
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

NOTE Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS: 1199 and Clause 7of IS: 456 shall be carried out.

3.09.00 **Size of Coarse Aggregates**

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer:

Very narrow space	-	12 mm
Reinforced concrete except foundation	-	20 mm
Ordinary Plain concrete and Reinforced concrete foundations	-	40 mm
Mass concrete	-	80 mm
Mass concrete in very large structure	-	150 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles:

150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10.00 **Mixing of Concrete**

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent

aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Ingredients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Batchers conforming to IS: 2722 may be used.

Batching plant conforming to IS: 4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within ± 1% of the quantity of Cement, water or total aggregates being measured and within ± 3% of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical/electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Engineer. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Engineer, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the Owner.

3.11.00 **Conveying Concrete**

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and

compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 **Placing and Compacting Concrete**

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

a) Earth foundation
b) Rock foundation
c) Formwork
d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Engineer and shall be allowed to cure prior to setting out, steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar will be deemed to be included in the unit rate of concrete.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The temperature of concrete shall not exceed 40 deg C measured at discharge into the works. However, for STG Top Deck and foundations for rotating equipments the temperature at discharge point of concrete shall not exceed 28 degree C or as per the instruction of the Engineer.

The maximum allowable temperature differential between any two points in the same element is 15 deg Additional temperature control measures during construction (such as use of insulated formwork) shall be required. Contractor to prepare a process control chart and method statement verifying measures to achieve these requirements.
The temperature monitoring of concrete work is required where:

a) the minimum dimension of any casting is 0.8m or more, or

b) where otherwise instructed by the Engineer

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken

in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation therefrom shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction. Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12. For water retaining structures and leak-proof buildings suitable approved water bars will be installed at the construction joints.

Where the locations of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.

c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 **Cold Joint**

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness will be placed on the cold joint, fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, the joint will be left to harden for at least 12 - 24 hrs. It will then be treated as a regular construction joint, after cutting the

concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 **Repairs, Finishes and Treatment of Concrete surfaces**

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner. All concrete work shall be inspected by the Contractor immediately after the forms are removed and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth and shape.

c) Cleaning of reinforcement and embedments. It may be necessary to provide an anticorrosive coating on the enforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortar.

k) Polymer modified patching and adhesive repair mortar for beams & columns.

3.14.02 **Finishing Unformed Surface**

The Contractor is to include in his quoted rate for concrete, the provision of normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc., as and where required by the Engineer without any extra cost to the Owner. A few typical and common cases of treatment of concrete surface are cited below:

a) **Floor**

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No overtrowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked without any extra cost to the Owner to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) **Beams, Columns & Walls**

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 **Protection and Curing of concrete**

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet, hessian, canvas or similar materials & kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Engineer, curing compound like "ANTISOLE (WP)" or approved equivalent may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer’s supervision at no extra cost to the owner.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision

regarding the adequacy of curing is final. In case any lapse on the part of the Contractor is noticed by the Engineer, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or pay for the part where adequate curing was not noticed at a reduced rate, entirely at the discretion of the Engineer.

3.16.00 **Reinforcement**

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 **Bar Bending Schedules**

The Contractor shall submit to the Engineer for approval of Bar Bending Schedules with working drawings in triplicate, showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.02 **Cleaning**

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 **Cutting & Bending of Reinforcement**

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete.

Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars

above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845 Deg.C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

3.16.04 **Placing in Position**

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 **Welding**

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.06 **Control**

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS:456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 **Cold Weather Concreting**

When conditions are such that any operation of concreting may be expected to be done at 5 Deg.C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS: 456 and IS: 7861(Part II).

3.18.00 **Hot Weather Concreting**

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40 Deg.C while placing. Positive temperature control by precooling, postcooling or any other method, if required, will be specified and paid for separately.

3.19.00 **Concreting under water**

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14.2 of IS: 456.

3.20.00 **Form Work**

3.20.01 **General**

The formwork shall be designed and constructed as per clause 11 of IS 456. Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The contractor shall prepare design & working drawings for formwork & temporary support system for important structures and get them approved by the Engineer prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the

working load. In case the Contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits will be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified free of charge as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion- resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, bevelled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges without any extra charge. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 **Cleaning and Treatment of Forms**

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings , saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like "Separol/Sika form oil/ Siparol Concentrate" or approved equivalent before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 **Design**

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of formwork shall take into account all vertical and lateral loads that the forms will carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pour of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sqm excluding weight of concrete. Regarding design and detailing of formwork, reference may be made to IS 14687.

3.20.04 **Inspection of Forms**

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 **Removal of Forms**

Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires.

The Contractor shall record on the drawing or in any other approved Banner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner. The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

TABLE – V

SCHEDULE OF REMOVAL OF FORM

	Ordinary Portland Cement Concrete				Rapid Hardening Portland Cement Concrete			
Part of Structure	Temperature Deg. C				Temperature Deg. C			
	> 40	40 -20	20 - 5	< 5	> 40	40 -20	20 - 5	< 5
	Days	Days	Days	Days	Days	Days	Days	Days
a)Columns & Walls	2	1	1	Do not remove forms until site cured test specimen develop at least 50% of the specified 28 days strength	1	1	1	Do not remove forms until site cured test specimen develop at least 50% of the specified 28 days strength
b)Beam sides	3	2	3		2	1	1	
c)Slabs, 125 mm	10	7	8		7	4	5	
d)Slabs over 125 mm thick and soffit of minor beams	18	14	16		12	8	9	
e)Soffit of main beams	24	21	22		14	10	12	

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40 Deg.C can be reduced to those of the temperature range of 20 Deg.C to 40 Deg.C subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

If any type of cement other than ordinary Portland cement and Rapid hardening Portland cement is used the time of removal or forms shall be revised as approved by the Engineer such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form as mentioned above. This has to be supported by regular tests.

3.20.06 **Tolerance**

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer:

For -	a)	Sectional dimension	-	± 5 mm
	b)	Plumb	-	1 in 1000 of height
	c)	Levels	-	± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 **Re-use of Forms**

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified herein before. Formwork shall not be used / re-used if declared unfit or unserviceable by the Engineer.

3.20.08 **Classification**

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Engineer:

a) **Ordinary**

These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) **Plywood**

These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit □hosphate□n of used plywood for the 'ordinary' class, if it is still in good condition.

c) **Ornamental**

These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

d) **Metal Decking**

The metal decking shall consist of cold rolled light gauge mild steel sheets conforming to IS: 513 having a troughed profile and a minimum thickness of 0.8 mm. The troughed profile of the sheet shall be such that the depth of the valley is minimum 44 mm and center to center of the valley is about 130 mm. The decking sheets are to be □hosphate on both sides conforming to IS: 3618. The phosphating shall be medium duty B class conforming to the above code. Over the phosphating the decking sheets shall be coated with one coat of chlorinated rubber paint applied on outside face at the manufacturer's work. Metal deck shall be installed strictly in accordance with manufacturer's recommendations.

3.21.00 **Opening, Chases, Grooves, Rebates, Blockouts etc.**

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 **Anchor Bolts, Anchors, Sleeves, Inserts, Hangers, Conduits, Pipes and other Miscellaneous Embedded Fixtures**

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to be painted with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer, free of cost to the Owner.

Items to be embedded -

a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structures to be left embedded for future extension, special connection etc.

d) Lugs or plugs for door and window frames occurring in concrete work.

e) Flashing and jointing in concrete work.

f) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 **Expansion and Isolation Joints**

3.23.01 **General**

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 **Bitumen Board/Expanded Polystyrene Board**

a) **Bitumen Board**

Bitumen impregnated fiber board of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) **Expanded Polystyrene Boards**

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 **Joint Sealing Strips**

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

Non-metallic sealing strips will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

a) **Rubber Sealing Strips**

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 – 30 N/Sq.mm
Max. Safe Continuous Temperature	:	75 Deg.C
Ultimate Elongation	:	Not less than 350%

b) **P.V.C. Sealing Strips**

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly:

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 – 15 N/Sq.mm
Max. Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 **Joint Sealing Compound**

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.05 **Isolation Joints**

Strong and tough alkathene or PVC sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 **Rubber Pad**

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness – 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 **Grouting under Machinery or Structural Steel Bases**

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. Finished grout shall be cured to ensure proper strength. If desired by the Engineer, admixtures like Aluminium powder, 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added, without any extra cost to the owner.

Alternatively non-shink, free flow, cementious grout like "Sikagrout 214 / Ankor NSG" / Masterflow 918 or approved equivalent specifically selected for the type of equipment to be located (vibrating , static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

3.25.00 **Concrete for Special Work**

3.25.01 **Precast Concrete**

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly leveled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportions) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which will not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the data of casting and if they are of a symmetrical section the face which will be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, leveling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centering have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement : sand mortar where called for in the drawings.

3.25.02 **Construction by Slip/ Jump/ Climb form Method**

Slip/Jump/Climb form method of construction when considered by the Bidder, type of process proposed for formwork should be indicated in the bid along with sketches, drawings and construction methods statement as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress (in case of slip form) in mm/hour should also be indicated. The chosen scheme shall be of a past proven design. A certified performance record of the scheme should be submitted with the offer to guarantee workability of the scheme both from execution time and safety point of view.

The Bidder should furnish a brief but comprehensive report indicating the planning and method of work to be followed at the time of submitting the Bid. This report shall include the following items :

Type and description of (Slip/Jump/Climb) formwork proposed along with Equipment and its accessories.

i) Design of scaffolding and staging.

ii) Description of materials including admixtures to be used for construction.

iii) Manpower planning, construction spaces required and standby arrangement.

iv) Temporary Lightning arrestor arrangement.

v) Rate of Slip-forming/average rate of Jumps/Climbs per week.

vi) Proposed workability requirement of concrete and type of cement & admixture to be used.

vii) Quality and safety assurance programme.

viii) Method of Transportation of material

ix) Planned interruption, if proposed and activities during planned interruption.

x) Treatment of construction joints.

xi) Contingency solution for unplanned interruptions.

xii) Time of completion.

While selecting the Contractor, due consideration will be given to the merit of the above mentioned method statement proposed by the Bidder and minimum time of completion, apart from his past experience in such types of work and also his technical and financial resources.

Notwithstanding what have been specified in earlier clauses, following guidelines are being presented which should be kept in view by intending Bidders, while quoting for Slip/Jump/Climb form method of construction:

1. Care to be taken to prevent dragging of concrete alongwith upward movement or removal of the shuttering. For this purpose following steps are advisable:

    a) Shutter plates have to be smooth and should be thoroughly clean.

    b) In areas where concrete thickness is 750 mm or more rate of pouring should be such that the minimum slipping rate of slip form is 100 mm per hour.

    c) Mix design should be so done that it will be self-lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant I.S. Specification) may be used for the purpose. An optimum ratio of coarse/fine aggregate should be established to suit the purpose depending on the type of aggregates used.

    d) Mix design also should be so done that it has a slump of minimum 50 mm at the point where concrete is placed under the ambient temperature conditions. This will also keep the required vibration by needle vibrators to minimum. Slump should not drop down to zero in less than 45 minutes. Suitable retarding agent and plasticizer of approved manufacture may be added in the mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for performance and for compatibility with particular type of cement and aggregates proposed to be used. The admixtures shall be used strictly as per the manufacturer's Specification.

    Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is higher than 40 Deg.C.

2. Care must be taken to prevent twist, which predominantly occurs in the initial stages because of low slipping rate, in the horizontal plane of Slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person should exclusively be assigned this work together with rectifying any defect.

3. Every endeavor has to be made to eliminate any tilt in the shutter assembly. To achieve this following steps need be taken:

   a) Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite jacks at any instant of time should not exceed 5 mm.

   b) Loading on Slip-form truss/yokes or A-Frame and hoist has to be fairly equal.

   c) Sleeves, through which the jacking rod passes for slip form shuttering, has to be of sufficient length so that the latter gets a uniform clearance and does not get any chance to tilt. Sleeves should have a minimum wall thickness of 3.25 mm and should be such that jacking rod gets a maximum clearance of 1 mm to 1.5 mm around.

4. In designing the mix following aspects should be borne in mind:

   a) Cement used should have an initial setting time of not less than 50 minutes and preferably should have a specific surface around 3700 Sq.Cm./gramme.

   b) Coarse and fine aggregates should be well graded and rounded aggregates offer better performance in Slip-form technique. These help to keep down water/cement ratio and also offer better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should preferably be used unless reinforcement detailing calls for lesser size aggregates.

   c) From the point of view of creep, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 Kg. per Cu.M of concrete.

   d) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slipform proceeds should not be less than 0.1 MPa.

   e) It is advisable to use cement from a single source during the entire operation of shell casting using slip form technique since once the operation starts, there might not be any time left for conducting further trial for design mixes if the source of procurement of cement changes.

5. Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter. 40 mm diameter may be used only in exceptional cases. Sufficient numbers (at least two) of standby vibrator units should always be maintained on top of working deck at all times during the entire period of shell casting operation.

6. Proper arrangement has to be made for adequate supply of curing water for continuous spraying on both inside and outside surfaces with spraying equipment. Necessary length of pipelines and pumps of adequate capacity and head to serve the purpose shall be made available with Stand-by arrangements.

   Membrane curing compounds may be allowed on fresh surfaces emerging out of shutter panels for curing. The applied compound has to be removed suitably before further surface treatment. If curing compound is to be used then the compound to be applied should be such that it may be removed easily without leaving any stain on the concrete surfaces.

7. Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

   It is desirable that the jacking system, based on which the slip/climbing form system works, should consist of jacks 3 Tonne to 6 Tonne capacity and hydraulic pump with necessary pipe connections.

   Spacing of yoke legs should preferably be kept within 2 metres to prevent overloading on jacks and consequent failure resulting in twist of the formwork.

   Jacking rods should be of 25 mm diameter for 3 Tonne Jacks and 32 mm diameter for 6 Tonne Jacks.

8. At least 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump along with a set of loose pipes in perfect working condition on top of working deck.

9. In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slipform yoke.

10. For effective utility of this technique following areas need careful attentions at the very conceptual stage :

a) Detailed quality assurance programme.

b) Advance Planning and preparations.

c) Arrangement for on-site supervision and adequate access facilities.

11. Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, description and frequency of various checks and tests for Slipform/climbing technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared beforehand by executing agency and to be approved by Engineer before starting the actual work.

12. Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

Vertical reinforcements should be kept vertical by providing suitable holders within the formwork system.

13. For Slip form process, in particular, it is desirable to have a planned break of at least one day for every two weeks of continuous operation. Such break should be utilized for various maintenance activities, removal of jack rods etc.

14. Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. If felt necessary one hoist may be exclusively earmarked for transporting concrete. For movement of personnel supervising the work a separate hoist must be arranged for.

15. If concrete is to be placed using concrete pumps then the complete operation such as mix design, transportation and placing of concrete, availability of sufficient equipment such as truck mixers, concrete pumps, placer booms etc. should be well planned and ensured before the concreting activities commence.

16. The slipform system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system along with slipform.

17. The vertical alignment must be checked constantly using laser equipment. Further manual checks should be performed using plumb bobs, theodolites or other means.

18. In case of interruption in the course of slipping of formwork following measures should be taken :

    a) Provision of a key and additional reinforcement at the junction of new and old concrete.

    b) Formwork system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.

    c) Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.

    d) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.

    e) Neatly finishing the interface of old and new concrete as soon as it comes out of shutter panel.

19. It is preferable to suspend the construction work under high wind condition and high lightning frequency.

20. It is of utmost importance that for effective implementation of this system an Engineer fully conversant with Slip/Jump/Climb form technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.

21. Operation of slip/Jump/Climb form method of construction is practically a continuous/continual operation and demands continuous and intermittent inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.

22. While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety Engineer.

    Safety measures as listed below must be adhered to but should not be limited to only these :

    a) Safety helmets and belts to be provided to a supervising staff and workers.

    b) Safety nets to be provided below both inside and outside platforms as instructed by Engineer.

    c) Handrailing & toe guard to be provided around all openings & platforms.

    d) Regular maintenance of equipment, checking of hoists, scaffoldings etc.

    e) Passenger hoist must have multiple ropes.

    f) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the Specification and to be operative in case of sudden power failure Emergency standby generator must be kept ready during the entire period of slipform method of construction.

    g) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

23. Permissible construction tolerances should be limited to the following:
    Variation in wall thickness : (-) 5 mm, (+) 25 mm

    Variation from Design Diameter : (+_) 12.5 mm per 3 m dia., but in no case more than (+_) 75 mm.

    Out of Plumb in General: 1 in 1000 of height subject to a maximum of 200 mm.

3.26.00 **Waterproofing of Concrete Structure**

3.26.01 **General**

Waterproofing of concrete structures shall be done by either suitable extraneous treatments like applying waterproofing paints like “Sikatop Seal” or approved equivalent, fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS: 2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer’s approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 **Water Bar/Seal/Special Treatment of Construction Joint**

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint should be provided as per clause 3.13.1 with or without water bar / Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods:

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer’s specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days:

Compressive strength	-	55 to 60 N / Sq. mm
Flexural Strength	-	25 to 30 N / Sq. mm
Tensile strength	-	15 N / Sq. mm (approx)
Bonding strength to concrete	-	3 N / Sq. mm (approx)
Bonding strength to steel	-	20 N / Sq. mm (approx)

The whole operation shall be done as per manufacturer's specification. The contractor shall provide manufacturer's supervision at no extra cost to owner.

Method 2 : One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 **Waterproofing Admixtures**

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %.

The maximum permissible dosage of admixture will be 3 % (three percent) by weight of cement but a lower dosage will always be preferred.

The product shall be stored in strong moisture proof packings.

However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water resistant concrete admixture shall be used as per manufacturer's specification to provide a waterproof concrete.

a) In concrete : The approved admixture shall be based on modified lignosulphonate like "Plastocrete – N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to the Owner to supervise the work, if desired by the Engineer.

b) In Plaster : The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "No leek CP/ Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost to the Owner. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 **Bituminous or Tar Coating on External Surface**

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS: 216 (not heated above 375 Deg.F) using not less than 2 Kg. per Sq.M. or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400 Deg.F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M. in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely. In place of hot application by coal tar / asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/ rubber protective coating of approved manufacturer.

3.26.05 **Protective Coating on Inside Surface**

Two coats of cement based two-components polymer modified flexible protective and waterproofing slurry having 1 mm thickness for each coat shall be applied on the walls/ floor after proper surface preparation as per manufacturer's specification. The slurry shall be applied by brush.

3.26.06 **Bitumen Felt : Application for Tanking**

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt shall be hessian base and/or fibre base as specified in Drawing/Schedule of Items. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well known □pecialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls is required, these will be paid extra under suitable items in the contract. A 10 (ten) years' guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this item of work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 **Polyethylene Films : Application in Walls or Base of Structures**

Waterproof treatment shall be applied as outlined and as per sequence given hereunder:

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6

ii) apply hot bitumen 80/100 grade (IS:73-1961) @ of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen

v) Lay hot bitumen 80/100 grade (IS:73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250 micron polyethylene film as second layer similar to (iii) above.

vii) Lay second layer of 100 gm. Brown craft paper laminated as (iv) above.

viii) Apply hot bitumen (straight run grade) to IS:73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

ix) Protecting with a layer of 75 mm plain cement concrete M10 or a layer of brick laid in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 **Protective coating on Concrete Surface**

3.27.01 **On Foundation**

The outside faces of foundation of important structures will be protected from adverse effect of soil/ underground water, if shown on drawing or instructed by the Engineer, by using rubber / bitumen emulsion protective coating of approved manufacturer.

3.28.00 **Waterproofing by Pressure / Chemical Grouting**

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non- shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.m and the thickness of epoxy resinous emulsion □aterproof paint (to be applied on the external surface of walls/ slabs) shall not be less than 700 microns.

4.00.00 **SAMPLING AND TESTING**

4.01.00 **General**

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.00 **Cement**

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out free of charge by the Owner if cement is supplied by him. In case the Contractor is directed to arrange for the supply of cement as per the terms and conditions of the Contract the tests shall be carried out by him without any expense to the owner. In case due to any circumstances, the agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Owner, Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the Owner or the Contractor. These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 **Aggregates**

The Contractor shall carry out any or all the tests for aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 **Water**

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS: 3025 & IS: 456.

4.05.00 **Admixture**

4.05.01 **Air Entraining Agents (A.E.A)**

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-à-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor free of charge by carrying out sufficiently large number of tests. Thereafter, the tests shall be carried out at regular intervals and whenever directed by the Engineer, the Contractor will check up free of charge, the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 **Other Admixtures**

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor free of charge to the Owner.

4.06.00 **Concrete**

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 15 of IS: 456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS: 1199 shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 16 of IS: 456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor without any extra cost to the owner. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 **ACCEPTANCE CRITERIA**

5.01.00 **Standard Deviation**

Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 9.2.4 of IS: 456.

5.02.00 **Acceptance Criteria**

The strength requirements and acceptance criteria shall conform to Clause 16 of IS: 456.

5.03.00 **Inspection and Core Tests**

Inspection of concrete work immediately after stripping the formwork and Core Test, Non-destructive Tests of structures shall conform to Clause 17 of IS: 456.

5.04.00 **Load Test**

Load tests of structural members may be required by the Engineer, when the strength of test specimen results fall below the required strength, as per 'Load Tests for flexural members', Clause 17.6 of IS: 456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to full dead load of the structure plus 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of 24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 28 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor free of cost to the Owner. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by derating its load bearing capacity, provided the design criteria allows such derating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS: 456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per the specification. The entire cost of dismantling and replacement and restoration of the site shall be borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 **LIST OF IS CODES AND STANDARDS FOR REFERENCE**

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:

IS : 73	-	Indian Standard Specification for Paving Bitumen
IS : 216	-	Indian Standard Specification for Coal Tar Pitch
IS : 383	-	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
IS : 432	-	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part 1 & 2
IS : 455	-	Indian Standard Specification for Portland Slag Cement
IS : 456	-	Indian Standard Code of Practice for Plain and Reinforced Concrete
IS : 457	-	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
IS : 513	-	Indian Standard Code of Practice for Cold Reduced Low Carbon Steel Sheet and Strip
IS : 516	-	Indian Standard Specification for Methods of Test for Strength of Concrete
IS : 737	-	Indian Standard Specification for Wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose
IS : 1199	-	Indian Standard Specification for Methods of Sampling and Analysis of Concrete
IS : 1200 (Part-II)	-	Indian Standard Specification for Method of Measurement Cement Concrete Works
IS : 1200 (Part-V)	-	Indian Standard Specification for Method of Measurement of Formwork
IS : 1322	-	Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing
IS : 1489	-	Indian Standard Specification for Portland - Pozzolona Cement - Part 1 & 2
IS : 1566	-	Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement
IS : 1609	-	Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

IS : 1786 - Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement

IS : 1791 - Indian Standard Specification for Batch Type Concrete Mixers

IS: 1834 - Indian standard specification for hot applied sealing compound for joint in concrete.

IS : 1838 - Indian standard specification for Preformed Fillers for Expansion Joint in Concrete Pavement and Structures (Non Extruding and Resilient Type)

IS : 2062 - Steel for general structural purpose.

IS : 2185 - Indian Standard Specification for Hollow and solid/ solid light wt. Cement Concrete Blocks - Part - 1 & 2

IS : 2210 - Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates

IS : 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII

IS : 2430 - Indian standard specification for method of sampling of Aggregate for concrete.

IS : 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

IS : 2505 - Indian Standard Specification for Concrete Vibrators Immersion Type

IS : 2506 - Indian Standard Specification for Screed Board Concrete Vibrators

IS : 2508 - Indian Standard Specification for Low Density Polyethylene Films

IS : 2514 - Indian Standard Specification for Concrete Vibrating tables

IS : 2645 - Integral Cement water proofing compound

IS : 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS : 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction

IS : 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part - 1: Pull out Test

IS : 3025 - Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & waste water - part - 1 to 37

IS : 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.

IS : 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4

IS : 3384 - Indian standard specification for / Bitumen primer for use in waterproofing and Damp proofing

IS : 3414 - Code of practice for Design and Installation of joints in Buildings

IS : 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS : 3558 - Code of Practice for use of Immersion Vibrators for Consolidating Concrete

IS : 3618 - Indian Standard Specification for Phosphate Treatment of Iron and Steel for Protection against Corrosion

IS : 3696 - Safety Code for Part-1: Scaffolding and Part 2: Ladders

IS : 3812 - Indian Standard Specification for Fly Ash for Use as Pozzolana & Admixture

IS : 4031 - Indian Standard Specification for Method of Tests for Hydraulic Cement - Part - 1 to 14

IS : 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site

IS : 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches

IS : 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers

IS : 4656 - Indian Standard Specification for Form Vibrators for Concrete

IS : 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant

IS : 4926 - Indian Standard Specification for Ready Mixed Concrete

IS : 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work

IS : 4991 - Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground

IS : 4995 (Part-I&II) - Indian Standard Specification for Design of Reinforced Concrete Bins for the Storage of Granular and Powdery Materials

IS : 4998 (Part - I) - Indian Standard Specification for Design of Reinforced Concrete Chimneys

IS : 5512 - Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials

IS : 5513 - Indian Standard Specification for Vicat Apparatus

IS : 5515 - Indian Standard Specification for Compaction Factor Apparatus

IS : 5751 - Indian Standard Specification for Precast Concrete Coping Blocks

IS : 5816 - Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders

IS : 5891 - Indian Standard Specification for Hand Operated Concrete Mixers

IS : 6452 - Indian Standard Specification for High Alumina Cement for Structural Use

IS : 6909 - Indian Standard Specification for Supersulphated Cement

IS : 6923 - Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators

IS : 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures

IS : 7242 - Indian Standard Specification for Concrete Spreaders

IS : 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete

IS : 7251 - Indian Standard Specification for Concrete Finishers

IS : 7320 - Indian Standard Specification for Concrete Slump Test Apparatus

IS : 7861 (Part-I&II) - Indian Standard Specification for Recommended Practice for hot and cold Weather Concreting

IS : 7969 - Safety Code for Storage and Handling of Building Materials

IS : 8041 - Indian Standard Specification for Rapid Hardening Portland cement

IS : 8043 - Indian standard specification for hydrophobic cement

IS : 8112 - Indian Standard Specification for 43 grade Ordinary Portland Cement

IS : 8142 - Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance

IS : 8989 - Safety Code for Erection of Concrete Framed Structures

IS : 9013 - Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens

IS : 9077 - Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction

IS : 9103 - Indian Standard Specification for Admixtures for Concrete.

IS : 9417 - Recommendation for welding cold worked bars for reinforced concrete construction

IS : 10262 - Recommended Guideline for concrete Mix Design

IS : 12269 - Indian standard specification for 53 grade ordinary Portland cement

IS : 12330 - Indian standard specification for sulphate resting Portland cement

IS : 12600 - Indian standard specification for low heat Portland cement

IS : 14687-Indian Standard Guidelines For Falseworks For Concrete Structures

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SECTION-IV

TECHNICAL SPECIFICATION
FOR
EARTHWORK IN EXCAVATION AND BACKFILLING

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SECTION-IV

TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

1.0.0 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. and all other details as may be required by the Engineer.

c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests Whenever required by the Engineer to assess the degree of compaction.

d) Construction, maintenance and removal after completion of Magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out under the scope of this tender including procurement of necessary licenses from proper authorities.

2.2.0 **Work to be provided for by others**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.3.0 **Codes and Standards**

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed :

IS:1200	:	Method of Measurement of Building and Civil (Part-I) Engineering work;Part-I Earthwork.
IS:2720	:	Determination of Moisture Content (Part-II)
IS:2720	:	Determination of Moisture content / Dry Relation (Part-VII) using Light Compaction.
IS:2720	:	Determination of Density Index (Relative Density) (Part-xiv) of cohesionless soils.
IS:2720	:	Determination of Dry Density , in place, by core (Part-xxix)cutter method .
IS:2720	:	Determination of Dry Density of soils, in place, xxviii) (Part-by sand replacement methods.
IS:3764	:	Safety code for Excavation work.
IS:4081	:	Blasting and Related Drilling Operations
IS:4701	:	Earthwork on canals

2.4.0 **Conformity with Designs**

The Contractor is to carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.5.0 **Materials to be used**

2.5.1 **General**

All materials required for the work shall be of best commercial variety and approved by the Engineer.

2.5.2 **Borrow Material**

Borrow material required for back-filling shall be excavated from approved locations and levels and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries, shall be used as fill material.

2.6.0 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work :

a) Lines, Levels and Grades :

i) Periodic surveys

ii) Establishment of markers, boards etc.

b) Back-filling :

i) Checking the quality of fill material

ii) Checking moisture content of the backfill

iii) Checking the degree of compaction

2.7.0 **Information regarding site conditions**

Surface and Sub-surface data regarding the nature of soil , rock , sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation there from shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, Sub-surface and / or sub-soil water to be encountered . He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

3.1.0 Setting Out

Within 15 days of award of Contract, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instructions for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, free of cost to the Owner in case any errors are noticed in the Contractor's work at any stage.

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross- sections for volume measurement or for cross-checking the depths obtained from tape measurements.

All records of levels, measurements etc. and also any drawing, cross section etc. made therefrom, shall be jointly signed by the authorised respresentative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing, etc.

The area to be excavated or filled shall be cleared outof fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600mm below ground level or 150mm below formation level whichever is lower. After the tree is cut and roots taken out the pot-holes formed shall be filled with good earth in 250mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burned or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.4.0 **Classification**

All earthwork shall be classified under the following categories :

No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occuring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**

This shall include :

i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely appllied ;

ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;

iii) soling of roads, paths, etc., and hard core ;

iv) macadam surfaces such as water bound, and bitumen/tar bound;

v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;

vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and

vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include :

i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;

ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;

iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin; and

iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include :

i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;

ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

iii) boulders requiring blasting.

e) **Hard Rock (blasting prohibited)**

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work, etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost (with cement concrete not leaner than 1:4:8 ordinary concrete or richer) as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those overcuts which are unavoidable will be made up by ordinary cement concrete 1:2:4 which will be paid for under appropriate rate, provided this overcut is not due to negligence of the Contractor. The decision of the Engineer as to the admissibility of such overcut for payment will be final. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks, etc. shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

3.5.2 Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips, etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started. No extra will be paid to the Contractor for such unavoidable temporary suspension of work.

3.5.3 Excavation in Hard Rock

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurements. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any other approved method and payment appropriate to blasting shall be made, unless otherwise mentioned in the Schedule.

3.5.4 Blasting

3.5.4.1 General

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superceeded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.5.4.2 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in- charge. The clear space between the fence and the magazine shall not be less than 90m. The megazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.

Magazine shoes without nails shall be used while entering the magazine.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any duststorm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.5.4.3 **Carriage of Explosives**

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 **Use of Explosives**

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging

operations shall be carried out by or under the personal supervision of the shotfirer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shotfiring cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shotholes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shotfirer himself. The shotfiring cable shall not be dragged along the ground to avoid possible damage to the insulation. The shotfiring cable shall be tested for continuity and possible short circuiting before it is used each time.

The shotfirer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the Engineer.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encirled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shotfirer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shotfirer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

When blasting is conducted in the neighbourhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shotholes and filling the same with light charge of explosives.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.5.5 **Disposal**

The excavated spoils will be disposed of in any or all the following manners :-

a) By using it for backfilling straightway.

b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.

c) i) By either spreading, Or

ii) spreading and compacting at designated filling areas and / or disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavationin rock should include the cost of disposal as per (d).

3.5.6 **Disposal of Surplus**

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner and if the Contractor wants to use it, he shall have to obtain it from the Engineer at a mutually agreed rate for the same.

All sound rock and other assorted materials like excavated bricks, etc. shall be stacked separately and shall be measured in stacks deducting 30% volumetric measure for voids.

3.5.7 **Protection**

The Engineer shall be notified by the Contractor as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

3.5.8 **Dealing with Surface Water**

All working areas shall be kept free of surface water as far as reasonably praticable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.

Where works are undertaken in the monsoon period , the Contractor may need to construct temporary drainage systems at his own cost to drain surface water from working areas.

3.5.9 **Dewatering**

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. (except where such dewatering would need installation of well points or deep wells for which separate payment will be made) Sumps made for dewatering must be kept clear of the foundations. Method of pumping shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

If necessary, the Engineer may direct the Contractor to continue dewatering beyond his original or extended contract period in which case he will be paid separately for dewatering as per terms mentioned elsewhere under payment and measurement, provided the Contractor has completed all the work satisfactorily.

3.5.10 Timber Shoring

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the reponsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250 x 40 mm sections as directed by the Engineer. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal walers of strong wood at maximum 1.2 metres spacings, cross strutted with ballies or as directed by the Engineer. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.5.10.2 Open Timbering

In the case of open timbering, the entire surface of the side of trench pit is not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer. In all other respects, specification for close timbering shall apply to open timbering.

3.6.0 Treatment of Slips

he Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back-filled later by him at his own expenses.

3.7.0 **Back-filling**

3.7.1 **General**

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.

3.7.2 **Filling and Compaction in Pits and Trenches around Structures**

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered, rammed and properly compacted to achieve a dry density of not less that 9o% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of Silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS-2720 part XIV. Earth shall be rammed with approved mechanised compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and levelled to proper profile as shown in the drawing and as desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch sould be kept on it and corrections done to optimise the moisture content.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.7.4 Filling in Trenches for Water Pipes and Drains

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintearated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings .

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling upto a depth of 300 mm or the diamter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

3.7.5 Filling in Disposal Area

Surplus material from excavation which is not required for backfilling will be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers will be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the Contractor.

In certain cases the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.8.0 Approaches and Fencing

The Contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.9.0 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered the work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer, at the Contractor's cost. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good free of cost by the Contractor while carrying out the back-filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.2.0 Back-filling

The degree of compaction shall be sufficient to achieve a dry density of not less than 90% of proctor's dry density at optimum moisture content as per IS-2720 (Part - vii) or a relative density of 75% as per IS-2720 (Part-xiv)as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification . The work of back-filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 With Tender

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted along with the tender.

5.2.0 After Award

After award of the Contract the successful tenderer shall submit the following for approval and adoption :

a) Within 30 days of Award of the Contract, the Contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures. In case the Earthwork Contractor is also the agency for the foundation work, the Earthwork programme is to be connected with the foundation programme. The programme should also show how the excavation and back-filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.

6.0.0 RATES

The rates for the items shall include cost of all materials consumed in the works, hire charges of materials, tools and plant, cost of labour, insurance, all transport, taxes, royalties, security and safety arrangements, supervision, profit etc. The rates of excavation shall also include the cost of dewatering (except where such dewatering would need installation of well points or deep wells for which separate payment will be made) and stacking the excavatedspoils properly within a lead of 30M, unless otherwise mentioned in the Schedule of items.

The Contractor will have to give a rebate if the excavated earth is directly used for back-filling.

Where back-filling is to be done with sand, it shall be of good quality from quarries approved by the Engineer. The rate shall include all operations including the cost of sand.

In case the Contractor is required to continue dewatering of the excavated pits beyond the period of the contract, original or extended, he will be paid separately for it as per the schedule of items only for the period beyond the final terminal date of the contract. The rate will be complete in all respects including the cost of consumables, if any.

7.0.0 MEASUREMENTS

7.1.0 Clearing and Grubbing

No separate measurement shall be done for this item for the purpose of payment in general except for cutting of trees having girth more than 30 cms. and works connected to this.

7.2.0 Excavation

Actual quantity of excavation required and approved by the Engineer shall be measured in Cu.M. No extra shall be paid for keeping the excavations dewatered as required for completion of the structure to come in. Necessary disposal of the spoils as described in the schedule of items shall be included in the quoted rate.

7.3.0 Shoring

The actual effective area of shoring as approved by the Engineer, shall be measured in Sq.M. All planks, wallings, verticals, struts, props and all other materials as required for the shoring and subsequent safe dismantling and removal shall be included in the rates quoted.

7.4.0 Back-filling

7.4.1 With Assorted Earth from Excavations for Foundations, Trenches etc.

Actual quantity of consolidated backfill shall be measured in Cu.M. The cost of lead, lift, etc. shall be as per schedule of items and included in the rate quoted.

7.4.2 **With Earth from borrow pits and stacks**

Actual quantity of consolidated back-filling or actual quantity of excavation in the borrow pits, or the excavated volume of the stack with a deduction of 30% for voids, in case filling is done by earth from stack, whichever is less, shall be paid in Cu.M. The lead, lift, etc. as mentioned in the Schedule of Items shall be included in the rates quoted.

7.4.3 **Sand filling**

Actual quantity of consolidated sand filling shall be measured in Cu.M. The rate shall include cost of sand and all necessary works for execution of the items.

7.5.0 **Leads and Lifts**

The leads for excavation and/or back-filling will be measured between the centroid of the actual disposal area and that of the plan of the pit. The distance between these two points will be measured along the shortest practicable haulage path as decided by the Engineer.

Lifts will be measured vertically between the average ground level from where the pit excavation was started and the botton level of the excavated pit. Level lines corresponding to the stages where

lifts become payable will be drawn on the cross section of the pit and the volumes of excavation contained between these horizontal planes will be computed and paid according to the corresponding rates.

7.6.0 **Dewatering**

Dewatering for work beyond the Contract period original or extended will be measured on the basis of horse power - hour which will be obtained by multiplying the estimated requirement of horse power required to run the pumps or actually employed, whichever is less, by the actual hours run, approximated to the nearest half hour.

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SECTION-XVII

TECHNICAL SPECIFICATION FOR FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.00 INSTALLATION

2.01.00 Scaffolding

For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other work in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not are allowed in pillars/columns less than one metre in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purpose shall be filled and made good before plastering.

Note : In case of special type of brick work, scaffolding shall be got approved from Engineer-in-Charge in advance.

2.01.00 Preparation of Surface

The cement plaster shall be 6 mm, 12mm, 15mm, 18mm or 20mm as specified in the item.

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 **Plastering**

2.02.01 **Mortar**

Mortar for plastering shall be as specified in the Schedule of Items.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

For lime gauged plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 **Application of Plaster**

Ceiling plaster shall be completed before commencement of wall plaster.

Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true surface, plaster about 15 x 15 cm shall be first applied, horizontally and vertically, at not more than 2 metres intervals over the entire surface to serve as gauges. The surface of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive troweling or over working or over working the float shall be avoided.

All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arises, provision of grooves at junctions etc. where required shall be done without any extra payment. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

When suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of wall and not to nearer than 15 cm to any corners or arrises. It shall not be closed on the body of the features such as plasters, bands and cornices, nor at the corners of arrises. Horizontal joints in the plaster work shall not also occur on parapet tops and copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Thickness

Where the thickness required as per description of the item is 20mm the average thickness of the plaster shall not be less than 20mm weather the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15mm while in case of stone work the minimum thickness over the bushings shall be not less than 12mm.

Curing

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitable protected from all damages at the contractor's expense by such means as the Engineer-in-Charge may approve. The dates on which the plastering is done legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

2.02.03 **Finish**

The plaster shall be finished to a true and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surface shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

Precaution

Any cracks which appear in the surface and all portions which sounds hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer-in-Charge.

i) When ceiling plaster is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6mm drawn with any suitable method with the wall while the plaster is green.

ii) To prevent surface cracks appearing between junctions of column/beam and walls, 150mm wide chicken wire mesh should be fixed with U nails 150mm centre to centre before plastering the junction. The plastering of walls and beam/column in one vertical plane should be carried out in one go. For providing and fixing chicken wire mesh with U nails payment shall not be made separately.

iii) Due to faulty construction, if the plaster thickness increases more than 20 mm, the contractor shall provide chicken mesh to hold the plaster, at his own cost.

Deductions in measurements, for opening etc. will regulated as Follows :

a) No deduction will be made for openings or ends of joints, beams, posts, girders, steps etc. up to 0.5 sqm in areas and no additions shall be made either, for the jambs, soffits and sills of such openings. The above procedure will apply to both faces of wall.

b) Deduction for opening exceeding 0.5 sqm but not exceeding 3 sqm each shall be made for reveals, jambs, soffits sills, sills, etc. of these openings.

i) When both faces of walls are plastered with same plaster,

ii) Deductions shall be made for one face only.

iii) When two faces of walls are plastered with different types of plaster or if one face is plastered and other is pointed or one face is plastered and other is unplastered, deduction shall be made from the plaster or pointing on the side of the frame for the doors, windows etc. on which width of reveals is less than that on the other side but no deduction shall be made on the other side.

iv) Where width of reveals on both faces of wall is equal, deduction of 50% of area of opening on each face shall be made from area of plaster and/or pointing as the case may be.

v) For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each plastered face of wall.

c) For opening exceeding 3 sqm area, deduction will be made in the measurements for the full opening of the wall treatment on both faces, while at the same time, jambs, sills and soffits will be measured for payment

In measuring jambs, sills and soffits, deduction shall not be made for the area in contact with the frame of doors, windows etc.

Cement Plaster with a Floating coat of Neat Cement

The cement plaster shall be 12, 15, or 20mm thick, finished with a floating coat of neat cement, as described in the item.

Specifications for this item of work shall be same as describe above except for the additional floating coat which shall be carried out as below.

When plaster has been brought to a true surface with the wooden straight edge, it shall be uniformly treated over its entire area with a pest of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quality of cement applied for floating coat shall be 1 kg per sqm. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in above shall apply.

18mm Cement Plaster (Two Coat Work)

The specification for scaffolding and preparation of surface shall be as described above.

Mortar

The mix and type of the aggregate specified in the description of item shall be used for the respective coats. Generally the mix of the finishing coat unless otherwise described in the item.

Generally coarse sand shall be used for the under coat and fine sand for the finishing coat , unless otherwise specified for external work and under coat work, the fine aggregate shall conform to grading zone IV. For finishing coat work the fine aggregate conforming to grading zone V shall be used.

Application

The plaster shall be applied in two coats i.e. 12 mm under coat and then 6mm finishing coat and shall have an average total thickness of not less than 18mm.

12mm under coat

This shall be applied as specified earlier except that when the plaster has been brought to a true surface a wooden straight edge and the surface shall be left rough and furrowed 2 mm deep with a scratching tool diagonally both ways, to form key for the finishing coat. The surface shall be kept wet till the finishing coat is applied.

6mm finishing coat

The finishing coat shall be applied after the under coat has sufficiently set but not dried and in any case within 48 hours and finished in the manner specified earlier.

Specifications for curing, Finishing and Precautions shall be as describe earlier.

6mm Cement Plaster on Cement Concrete and Reinforced Cement

Concrete Work

Scaffolding

Stage scaffolding shall be provided for the work. This shall be independent of the walls.

Preparation of Surface

Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed with wire brushes. In addition concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacing of not more than 5 cm. Centers, the pock being made not less than 3mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

Mortars

Mortar of the specified mix using the types of sand described in the item shall be used.

Application

To ensure even thickness and true surface, gauges of plaster 15 x 15 cm. shall be first applied at more than 1.5m intervals in both directions to serve as guides for the plastering. Surface of these gauged areas shall be truly in the plane of the finished plaster surface. The plaster shall be then be applied in a uniform surface to a thickness slightly more than the specified thickness and shall then be brought to true and even surface by working a wooden straight edge reaching across the gauges. Finally the surface shall be finished true with a trowel or with wooden float to give a smooth or sandy granular texture as required. Excess troweling or over working of the floats shall be avoided. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Plastering of ceiling shall not be commenced until the slab above has been finished and centering has been removed. In the case of ceiling of roof slabs, plaster shall be commenced until the terrace work has been completed. These precautions are necessary in order that the ceiling plaster is not disturbed by the vibrations set up in the above operations.

Finish

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

Thickness

The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5mm.

Curing

The specification as stated earlier

Precautions

The specification as stated earlier

Deductions

Deduction shall not be made for openings or for ends of columns, or columns caps of 0.5sqm each in area and under. No additions will be made either for the plastering of the sides of such openings. For openings etc. of areas exceeding 0.5 sqm deduction will be made for the full opening but the sides of such openings shall be measured for payment

2.02.04 **Other Finish**

Generally, the standard finish shall be used unless otherwise shown on drawing or directed by the Engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the Engineer regarding the texture, colour and finish.

a) **Standard Finish**

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) **Neat Cement Finish**

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. Per Sq.M. or as per schedule and rubbed smooth with a trowel.

c) **Coloured Plaster Finish**

This shall be done in the same way as specified in clause 6.1.2.2.2 but using coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest edition.

Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) **Pebble-dash Finish (In Situ Work)**

The specification shall be the same as for rough cast plaster, except that the washed pebble or crushed stone graded from 12.5 mm to 6.3mm or as specified shall be dashed over the plaster base and the vacant spaces if any shall be filled in by pressing pebbles or crushed stone as specified by hand, so that the finished surface represents a homogeneous surface.

Specification for scaffolding, preparation of surface and mortar shall be as described earlier.

e) **Rough-Cast Finish**

Rough cast finish comprises of a mixture of sand and gravel in specified proportions dashed over a freshly plastered surface.

Preparation of surface

The joints shall be raked out, dust and loose mortar, shall be brushed out. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

Mortar

Mortar of specified mix using the type of sand described in the item shall be used, where coarse sand is to be used, the fineness modulus of the sand shall not be less than 2.5mm

Application

The plaster base over which roughcast finish is to be applied shall consist of two coats, under layer 12mm thick and top layer 10mm.

12mm Under Layer

This shall be applied in the same manner as specified in earlier under 18mm cement plaster except that the finishing, after the mortar has been brought to a level with the wooden straight edge, shall be done with wooden float only.

Top Layer

The top layer shall be applied a day or two after the under layer has taken initial set. The latter shall not be allowed to dry out, before the top layer is laid on. The mortar used for applying top layer shall be sufficiently plastic and of rich mix 1: 3 (1 cement: 3 fine sand) or as otherwise specified so that the mix of sand and gravel gets well pitched with the plaster surface. In order to make the base plastic, about 10% of finely grouted hydrated lime by volume of cement, shall be added when preparing mortar for the top layer.

Finish

It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state. The rough cast mixture shall consist of sand or gravel or crushed stone of uniform colour from 2.36 mm to 12.5mm or as specified and in the proportions as specified accurately to the effect required. The mixture gets well pitched into the plaster base. The mix shall again be dashed over the vacant spaces if any so that the surface represents a homogeneous surface of sand mixed with gravel. A sample of rough cast plaster shall be got approved by the Engineer-in-charge.

Specification for other details like precautions etc. as described earlier.

f) **Scraped Finish**

Ordinary plaster as described under Clause 6.1.2.2.2 after being levelled and allowed to stiffen for a few hours shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

g) **Textured Finish**

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 6.1.2.2.2. Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) **External Quality Glass Mosaic Tiles**

Glass mosaic tiles to be laid in pattern and profiles on a bed of cement mortar 1:3 (with coarse sand) and set in cement paste or adhesive of approved quality & make, joints filled and finished by neat in pigmented cement or sealant of approved quality & brand and cured including necessary adjustment at edges corners etc. complete, strictly as per the manufacturer's specification & details. in walls, ceiling, soffits up to all elevations in straight or curved surface as murals or wall claddings per drawing & instruction of the Engineer-in-charge.

The following important steps to be followed for installation of "Glass Mosaic" tiles

Preparing the surface

The surface to be tiled must be clean, smooth and clean of dust. It must be in plumb and should be dry.

Application of adhesive

A good quality Latex-Modified thinest to be applied as approved by Engineer-in-charge for fixing of mosaic tiles. Thinset should be compatible with the substrate and environment (i.e. wet areas or exterior areas). The adhesive should be thick enough to avoid mosaic sheets from slipping once placed on the wall. Spread the adhesive uniformly (about 3mm thick) on the wall using the straight edge of the trowel. With the toothed edge of the trowel, comb the adhesive through.

Installation mosaic mounted on paper

Mosaic sheets with the paper side to be faced up. After pressing the sheets firmly in one direction, rubbers float to be used to tap the sheets. A wooden float may also be used but never a metal one. It is to check that all sheets are placed at the exact same distance from each other as the tiles.

After the mosaics have started to set, but before they become fully bonded the paper the paper should be removed. A damp sponge to be used on the surface of the sheets to ensure easy removal of the paper. Paper to be removed carefully by pulling one corner of the paper diagonally across the sheet. This must be done gently to ensure that no tiles are dislodged in the process. Realign any tiles with a spatula and remove excess adhesive at this point. Let the adhesive dry for approximately 24 hrs before beginning the grouting process.

Installation of mosaic mounted on mesh

Mosaic sheets with the mesh backing to be installed by pressing directly on the adhesive. A rubber or wooden float to be used to tap the sheets to ensure a flat and even surface. It is to check that all sheets are placed at the exact same distance from each other as the tiles. Adhesive to be applied as much as possible so that it can be covered with in 10 to 20 minutes or until surface is still wet and tacky. Tiles to be allowed to set until firm. Clean excess adhesive from the surface of the tile to set firm. Clean excess adhesive from the surface of the tile with wet cloth or sponge while the setting material is fresh. Leave the surface to dry before beginning the grouting process.

Grouting

Sponge & warm water to be used to remove any excess adhesive on the sheets. The surface must be free from dust. Using a hard rubber float, spread the grout horizontally and vertically on the mosaic sheet. Cover an area of not more than 2 sq mtr. at a time. Excess grout to be removed with the rubber float by working diagonally across the mosaics. After grouting, wait approximately 20 minutes before cleaning the excess grout.

Material specification

Glass mosaic tiles to be either gloss or mat finish quality with the size 20x20mm to 25x25mm, weight 7.5 kg to 8.7 kg per sqm, thickness 3.8 to 4.5mm, water absorption < 0.1%. It should have excellent stain resistant, UV resistant, frost resistant, thermal shock resistant and chemical resistant property. Size and type of tiles (Gloss or matt finish) to be as per drawing and approval of the Engineer-in-charge.

i) **1st Quality Ceramic Glazed External Wall Tiles**

Ceramic exterior wall tiles of work size 150 x 300mm (textured surface) with thickness varies from 8.5mm to 10mm on a single tile due to 3D surface, applicable only for wet cladding. It should conform to ISO 13006 / EN 159 Group B III. The linear thermal expansion of tiles should be 9 X $10^{-6}K^{-1}$, Max.

Application

Surfaces to be tiled must be dry, clean and free from all contamination and should be dried and cured for at least two weeks.

The adhesive should be added to clean water and mixed thoroughly until a slump-free mortar is obtained. The adhesive is immediately ready – for- use and has a pot life of 3 hours. No further water should be added.

1. Spread not more than 1 sq.m. at a time , apply the adhesive to the wall surface.

2. Comb the adhesive to the required depth (between 3-6 mm) using a suitable trowel.

3. Press the tiles firmly into position with a slight twisting action, checking periodically that good contact is maintained with the back of each tile. Leave no voids behind the tiles when solid-bed fixing.

4. Tiles should be fixed within 20 minutes of the adhesive being applied, depending on the porosity of the surface and atmospheric conditions. Tiles can be adjusted up to 5-10 mins. after fixing.

5. Leave adequate joints (2-3 mm) between individual wall tiles by using spacer & to be grouted with polymer grout. This has to be maintained to avoid expansion – contraction problem due to climatic change as it will be exposed to sun.

6. Clean off surplus adhesive from the tile face and between joints.

7. Do not use in damp conditions.

8. Grouting should not be carried out for at least 24 hours.

j) **Heritage Granular Finish Work**

Heritage granular finish should be with special silica sand coloured wide inorganic pigments along with acrylic co-polymer bonding agent containing biocides / fungicides and stabilizing adhesive. Application thickness will be 0.8mm to 1.2 mm as per JISA 6909.

The application to be done on plastered surface at all elevations as per design, drawing, manufacturers specification and direction of Engineer-in-charge, complete in all respect

2.03.00 **Pointing to Masonry**

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 **Plaster with Metal Lath**

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers. The mortar for plastering shall consist of 1 part cement, 1/2 part lime and 4 parts sand by volume, or 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 6.1.2.2.1. The application, finish etc. shall be as specified under relevant clause above. Where called for in the Schedule of Items, a 2 mm Plaster of Paris punning shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 **Lime Punning**

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 **Plaster of Paris Punning**

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 **Stone Facing**

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings and/or schedule of items. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable noncorrodable anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings and/or Schedule of Items.

2.08.00 **White Cement Putty Punning**

Plastered surfaces, where specified shall be finished with White Cement Putty punning. The material shall be from approved manufacturers and approved by the Engineer. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 sq.m. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

	PROPERTY	
1.	Tensile Adhesion Strength (N/MM^2) @ 28 Days	> 1.0
2.	Compressive Strength (N/MM^2) @ 28 Days	> 9.0
3.	Setting Time (Minutes) - Initial Final	=> 100 =< 500
4.	Water Absorption Coefficient - $Kg/M^2.H^{1/2}$	< 1.0
5.	Water Capillary Absorption (ML) @ 24 Hrs.	0.8
6.	Water Retentivity %	> 98

Surface Preparation

All loosely adhering materials on the plastered wall surface is to be removed with the help of emery stone, putty blade or wire brush and clean water. The substrate should be cleaned, free from dust, grease and loose materials. Dry and absorbent surface should be moistened with sufficient quantity of clean water.

Mixing

White cement putty should be mixed slowly with 30-35% of clean water to form a paste. Mixing is to be continued for 10-15 minutes to form a uniform paste.

Application method

First coat shall be applied on well moistened plastered wall surface from bottom to upward direction uniformly with putty blade. After drying of first coat the surface shall be rubbed gently with wet sponge or putty blade to remove loose particles. Surface shall be allowed 3 hours to dry before applying the second coat. After complete drying of second coat, loose particles shall be removed by gently rubbing the surface with wet sponge or putty blade. After mixing the putty should be utilized within 2 hours. Total thickness of coats shall not be more than 1.5mm or as per manufacturer specifications.

2.09.00 **Cement Water Proofing Compound**

It shall be used for cement mortar for plastering or concrete work.

Water Proofing Compound

Integral cement water proofing compound conforming to IS 2645 and of approved brand and manufacturer, enlisted by the Engineer-in-Charge from time to time shall be used.

The contractor shall bring the materials to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended by the manufacturers or as specifically described in the description of the item. Care shall be taken in mixing, to see that the water proofing material gets well and integrally mixed with the cement and does not run out separately when water is added.
It shall be measured by weight.

The rate shall include the cost of all labour and materials involved in all the operations described above.

3.00.00 **ACCEPTANCE CRITERIA**

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 **RATES**

Rates shall be for the complete work as detailed out in the specification unless any particular portion is specifically excluded in the Schedule of Items.

5.00.00 **METHOD OF MEASUREMENT**

a) All surface finish shall be measured on actual area laid. No deductions shall be made for openings, pipes, and sleeves etc. upto 0.1 Sq.M. in area.

b) Unless separate item is provided for special corner or edge finish, drip course, grooves, mouldings, curbs etc. these shall not be measured separately. Where separate item is provided in the Schedule of Items, such work shall be measured for length.

c) No separate payment shall be made for finishing round openings, sleeves, pipes, etc. No separate payment shall be made for formwork, templates etc. required for achieving true lines and profiles as shown on drawing.

d) Finishes applied integrally with walls, floors, steps and ceilings shall be measured separately and paid under relevant items.

e) Any reinforcement incorporated in the finish shall be measured and paid separately under relevant items.

f) Unless otherwise mentioned in the Schedule of Items, hangers, supports and laths for lath plastering shall be measured and paid separately under relevant items.

6.00.00 **I. S. CODE**

Important relevant code for this Section :

a)	IS : 1661	:	Code of practice for cement and cement-lime plaster finish on walls and ceilings.
b)	IS : 4101	:	Code of practice for external facings and veneers.
c)	IS : 1200 (Pt-XII)	:	Method of Measurements of Building and Civil Engineering Works: Part: XII- Plastering and Pointing

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SECTION-III

TECHNICAL SPECIFICATION FOR AREA GRADING

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SECTION-III

TECHNICAL SPECIFICATION FOR AREA GRADING

1.0.0 SCOPE

This specification shall govern all clearing, grubbing, excavating, area filling, grading and compacting soils for areas designated on the drawings. The work shall include excavation, hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for subgrade, placing and compacting soils in fills, pumping to keep excavated areas dry, final grading of designated areas, disposing off unsuitable and excess excavated materials and incidentals thereof.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, earth-moving machineries and equipment, tools and plants, survey instruments, transportation etc. required for the work.

b) Prepare and submit working drawings showing the approaches, slopes, berms, sumps for dewatering, space for temporary stacking of spoils, disposal area, borrow pits, fencing etc. and all other details as may be required by the Engineer.

c) To carry out and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

d) If blasting is resorted to, necessary licenses to be procured from the proper authorities.

2.2.0 **Work to be provided for by others**

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

However, the Owner reserves the right to award the whole work to one Contractor or to split up the work for awarding to two or more Contractors.

2.3.0 **Codes and Standards**

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed :

IS : 3764 : Indian Standard for Safety Code for Excavation Work.

IS : 1200 : Indian Standard Method of Measurement of Building (Part-I)and Civil Engineering Work Part-I - Earthwork.

IS : 4701 : Indian Standard Code of Practice for Earthwork on Canals.

IS : 4081 : Safety Code for Blasting and Related Drilling Operations.

2.4.0 **Conformity with Designs**

The Contractor shall carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.5.0 **Materials to be used**

2.5.1 **General**

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.5.2 **Borrow Material**

Borrow material required for area filling shall be excavated from approved locations and levels and shall consist of selected material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material.

2.6.0 **Quality Control**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work :

a) Lines, Levels and Grades :

i) Periodic Surveys

ii) Establishment of markers, Boards etc.

iii) Checking levels and slopes of the graded surface.

b) Area filling :

i) Checking the quality of fill material

ii) Checking moisture content of the fill

iii) Checking the degree of compaction.

2.7.0 **Information regarding Site Conditions**

Boring and sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawings or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the Contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and/or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the Contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

3.1.0 Setting Out

Within 15 days of award of Contract, the Contractor will prepare and submit to the Engineer, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Engineer with modifications and corrections if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instruments for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Contractor's work at any stage, the same shall be remedied by the Contractor at his own cost.

3.2.0 Initial Levels

Initial levels either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements.

3.3.0 Clearing and Grubbing etc.

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bush vegetation, rubbish, slush, etc. and levelled up. Trees upto 300 mm girth shall be uprooted. Trees above 300mm girth which are required to be cut, shall be got identified by the Engineer and then marked.

Felling of trees shall include taking out roots upto 600 mm below ground level. After the tree is cut and roots taken out, the pot- holes formed shall be filled with good earth in 250 mm layers and compacted to acceptable degree unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer and then shall be transported to the Owner's store or any other space as directed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be Ash shall be spread or removed as directed by the Engineer. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.4.0 **Classification**

Materials involved in earthwork shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Engineer's decision in regard to such classification shall be final and binding on the Contractor :

a) **Ordinary and hard soil**

This shall include clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction. Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

b) **Soft and Decomposed Rock**

This shall include rocks like chalk, slate, mica schist, laterite and other similar materials which in the opinion of the Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, wedges, pneumatic breaking equipment etc. It shall also include boulders with dimensions greater than 500 mm but not exceeding 1000 mm in any direction. The mere fact that the Contractor resorts to blasting for his own convenience shall not mean that the rock will beclassifiedas hard rock.

Excavation in macadam and tarred roads and pathways, brick work etc. shall be considered at the same rate as excavation of this type of soil.

c) **Hard Rock**

This shall include rocks occuring in large masses which cannot be removed except by blasting. Harder varieties of rock such as trap, with or without veins and secondary mineral which in the opinion of the Engineer require blasting for removal shall also be considered as hard rock. It shall also include boulders bigger than 1000 mm in any direction. Construction in concrete, both reinforced and unreinforced, which is required to be dismantled during earthwork, shall be measured under this item, unless a separate provision is made in the schedule of Quantities for the same.

3.5.0 **Earthwork in Excavation**

3.5.1 **General**

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, dewatering, disposal, etc.

This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer and the Contractor shall be paid for the extra excavation and the filling at the appropriate item rates.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost with selected earth and compacted to 95% of modified Proctor Density or as directed by the Engineer.

The excavation shall be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures or works roads, railway tracks, cables, pipelines etc. if any, and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation.

On completion, the work will be finally checked and approved by the Engineer. In cases where excavation in soil, soft and decomposed rock and/or hard rock are involved, the soil or soft and decomposed rock layers, shall be removed by turn and levels of the underlying rock surfaces observed to enable measurements. Further work shall be resumed after getting clearance from the Engineer.

3.5.2 Excavation in Hard Rock

Overburden, if any, consisting of top soil, ordinary and hard soil, soft and decomposed rock as per classification of soil, which do not require blasting shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurement. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any other approved method. All loose or loosened rock in the sides shall be removed by barring, wedging, etc. The unit rate for excavation in hard rock shall include the cost of all these operations.

3.5.3 Blasting

3.5.3.1 General

Excavation shall be continued in hard rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencent of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines for the excavation, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Unless otherwise stated herein, I.S. Specification IS:4081 "Safety Code for Blasting & Related Drilling Operation" shall be followed.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting licence from the authorities concerned.

Contractor shall obtain necessary licence for storage of explosives, fuses and detonators issued to him from owner's stores or from supplier arranged by him, from the authorities dealing with explosives.

The fees, if any, required for obtaining such licence, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Govt. authorities and statutory bodies/ regulations.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

Contractor shall employ a competent experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

The blasting of rock near any existing buildings, equipments or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges and where directed by Engineer, a trench shall have to be cut by chiselling prior to the blasting operation seperating the area under blasting from the existing structures.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M 100. The cost of filling such excess depth shall be borne by Contractor and the excavation carried out beyond the limit specified above will not be paid for. Stepping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Owner's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other authority duly constituted under the State and/or Union Government.

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superceeded by the above rules.

No child under the age of 16 and no person who is in a State of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.5.3.2 **Storage of Explosive**

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in- charge. The clear space between the fence and the magazine shall not be less than 90m. The megazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.

Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detowators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.

Magazine shoes without nails shall be used while entering the magazine.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any duststorm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.5.3.3 **Carriage of Explosives**

Dctonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.3.4 **Use of Explosives**

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shotfirer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shotfiring cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shotholes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shotfirer himself. The shotfiring cable shall not be dragged along the ground to avoid possible damage to the insulation. The shotfiring cable shall be tested for continuity and possible short circuiting before it is used each time.

The shotfirer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encirled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shotfirer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shotfirer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until atleast half an hour after firing.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.5.4 **Disposal**

The excavated spoils will be disposed off within the specified lead in any or a combination of some of the following manners, as directed by the Engineer :

a) By stacking separately the materials suitable for area filling and materials not suitable.

b) By stacking it temporarily for use in backfilling at a later date.

c) i) By either spreading
or
ii) Spreading and compacting at designated disposal areas.

d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in back-filling or other purposes by some other agency.

The rate for excavation in soil should include the cost of filling and compaction in case (c) (ii). The rate for excavation in rock should include the cost of disposal as per (d).

3.5.5 **Dewatering**

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer, any water inclusive of rain water and subsoil water accumulated in the area without any extra cost. Method of dewatering shall be got approved by the Engineer.

3.6.0 **Treatment of Slips**

The Contractor will take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and backfilled later by him at his own expenses.

3.7.0 **Earthwork in Filling**

3.7.1 The material to be used for area filling shall be selected material, approved by the Engineer, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits in selected areas designated by the Engineer. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

Where excavated material is mostly rock, the boulders shall be broken into pieces not longer than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixtures used for filling.

If any material is rejected by the Engineer, Contractor shall remove the same forthwith from the site at no extra cost of the owner. Surplus fill material shall be deposited/disposed off as directed by the Engineer after the fill work is completed.

No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.

Before commencement of area filling the existing top soil shall be removed upto a minimum depth of 150 mm, or more, as directed by the Engineer in order to clear the surface of undesirable materials. After this the filling operation shall be performed with earth in layers not exceeding 250 mm, loose thickness. Each layer shall be watered and properly compacted to 95% of modified Proctor Density unless otherwise permitted/directed by the Engineer. Earth shall be compacted with approved machine and usually manual compaction shall not be allowed unless specifically permitted by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimise the moisture content. The adequacy of the compaction and moisture control of the soil shall be determined by performing field density tests and other tests as and when directed by the Engineer and shall conform to the stipulations laid down in IS:4701.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms. approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.7.2 **Filling in Disposal Areas**

Excavated materials if not used in area filling, will be disposed off in designated disposal areas as directed or as indicated in the drawings. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500 mm in thickness and nominal compaction done to the satisfaction of the Engineer. All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

In wide areas rollers may be employed and nominal compaction done to the satisfaction of the Engineer. No payment for compaction shall be made for such nominal compaction.

3.8.0 **Approaches and Fencing**

The Contractor shall provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the area shall be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress, if directed by the Engineer.

3.9.0 **Lighting**

Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. Even if no night work is in progress, red warning lights should be provided at the top in edges of the excavated area and the edges of the fill, unless otherwise permitted by the Engineer.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimensions of the area will be checked as per the drawings after the area is completely dewatered.

The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by compacted earth, at the Contractor's cost.

Over excavation of the sides will be made good free of cost by the Contractor. The excavation work will be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.2.0 Area-filling

The degree of compaction required will be as per the stipulations laid down in appropriate sections of this specification. The actual method for measuring the compaction achieved will be as decided by the Engineer. The work of area filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.0.0 INFORMATION TO BE SUBMITTED

5.1.0 With Tender

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted along with the tender :

I) Equipment, machinery & earthmoving vehicles, available with the Contractor and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.

ii) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.1.0 (i) above.

iii) Method of transportation.

5.2.0 After Award

After award of contract the successful tenderer shall submit the following for approval and adoption :

a) Within 15 days of Award of the contract, the Contractor shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme should also show how the excavation and area- filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits,if any, fencing etc. for approval of the Engineer for adoption.

6.0.0 RATES

6.1.0 Excavation and Disposal

The rates of earthwork for all types of soils, soft and decomposed rock and hard rock and leads as listed in the Schedule of Items will include the cost of all materials consumed, hire charges of tools and plants and equipment, cost of labour, insurance, taxes and royalties, security and safety arrangements, power, fuel, lubricants, services, accommodations, supervisions, overheads, profits etc.

The rates of excavation should also include the cost of dewatering. The Contractor will have to give a rebate for non-compaction in case the excavated material is stacked for use in back-fill by some other agency at a later date or dumped and spread in the disposal area with nominal compaction.

6.2.0 Area-Filling by Excavated Earth and Compaction

The rates to be quoted for this item should be complete in all respects including transporting earth available from excavation under Cl. 6.1.0 and include all the components of cost listed under Cl. 6.1.0. No extra will be payable for filling at any depth.

6.3.0 **Area-Filling by Earth brought from Borrow Pits or Stacks left by other Agencies**

In case sufficient earth of proper quality is not available from the excavated spoils, the Engineer may direct area filling to be done by bringing earth from borrow pits or selectively from stacks left by other agencies. The material in the stacks which are considered by the Engineer to be unfit for use in the fill, shall be carted away by the Contractor to the disposal area.

The rate to be quoted against the relevant item of the schedule should be complete in all respects and include all the components of cost listed under Cl.No. 6.1.0 of this specification. No extra will be payable for filling at any depth. Leads will however be paid as per Schedule of Items.

6.4.0 **Dewatering**

The rate for any dewatering of the area during the period of contract, original or extended, shall be deemed to have been included in the unit rate of excavation.

~~7.0.0 **MEASUREMENT**~~

~~7.1.0 **Clearing and Grubbing**~~

~~No separate measurement shall be done for this item for the purpose of payment in general, except for cutting of trees, having girth more than 300 mm.~~

~~7.2.0 **Excavation and Disposal**~~

~~Actual quantity of excavation required and approved by the Engineer shall be measured in Cu.M. No extra shall be paid for keeping the excavations dewatered as required. Necessary disposal of the spoil for filling or stacking as described in the Schedule of Items shall be included in the quoted rate.~~

~~The measurement may be done by direct tape measurement or by cross sections derived from initial and final levels.~~

~~7.3.0 **Area Filling with Earth from Stacks**~~

~~Actual quantity of filling as worked out from the contour drawings or the volume of the stack with a deduction of 30% (thirty percent) for compensating the voids shall be measured in Cu.M. The measurements will be taken before any monsoon passes over the area.~~

7.4.0 **Area-Filling with Earth from Borrow Pits and Stacks**

Actual quantity of excavation in the Borrow pits, or the volume of the stack with a deduction of 30% percent for voids, in case filling is done from stacks, shall be measured in Cu.M. The lead as mentioned in the Schedule of Items shall be included in the rates quoted.

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SECTION-XVI

TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORK

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SECTION-XVI

TECHNICAL SPECIFICATION FOR MASONRY AND ALLIED WORK

1.00.00 SCOPE

This specification covers furnishing, providing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

2.00.00 INSTALLATION

2.01.00 Soling

2.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of Item. Orientation shall be as desired by the Engineer. After lying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

2.02.00 Brick Edging

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

2.03.00 **Masonry**

2.03.01 **General**

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.03.02 **Mortar**

Mix for mortar shall be specified in the Schedule of Items.

When lime is used hydrated lime shall be mixed with water to form putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 sieve and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out. For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

Lime shall not be used where reinforcement is provided in brick work.

2.03.03 **Brick Masonry**

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. For brick work in half brick wall, bricks shall be laid in stretcher bond. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar. At the joint of brick masonry with RCC column/beam/wall, the mortar shall be with rich grade to avoid shear cracks.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. The inside face of the brick work shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow space are left inside the joints. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

2.03.04 **Exposed Brickwork**

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by especially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of windowsills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified in the Schedule of Item, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.03.05 **Reinforced Brickworks**

Reinforcements shall be as specified in the Schedule of Items. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. Columns or welded to steel stanchions.

2.03.06 **Cavity Wall**

It is wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 50mm and not more than 115mm. Each leaf of the cavity wall shall not be less than 75mm. The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material.

2.03.06.01 **Metal Ties**

These may be of galvanized iron, wrought iron, gun metal, brass, copper, stainless steel or ant such corrosion resistant metal, made of flats 20 x 5 mm cranked or twisted at their mid point with ends split and fish tailed. The ties shall be built into horizontal bed joints during erection, placed sloping towards the exterior side to prevent water from flowing along it from outer to inner leaf side.

2.03.06.02 **Bonding Units**

These shall be preferably precast R.C.C. units.

Length of the Bonding units will be sum of thickness of both leaves plus width of cavity if the leaves plus width of cavity if the leaves are 75mm or 115mm. If the leaves are more than 115mm thick, then the length of a unit will be 2x115+width of cavity. Precast RCC units shall be provided with 2 no. , 6mm mild steel reinforcement bars tied with 2 no. 3 mm. dia. wire/hard drawn wire cross bars placed in the centre of units.

Cement concrete used in the bonding units shall not be leaner than 1:3:6 (1cement: 3coarse sand: 6 graded stone aggregate 20mm nominal size)

2.03.06.03 **Spacing**

Metal ties/bonding units shall be spaced not more than 90cm apart horizontally and 45cm vertically and staggered in each course. Additional ties shall be used near openings.

2.03.06.04 **Restrictions**

Cavity walls shall not normally be built more than 7.5 metres in height and 9 metres in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc. Cavity shall be covered at the top with at least two courses of masonry unit and/or a coping over it.

Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls.

2.03.07 **Stone Masonry**

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. Al least two stones shall run the full width of the wall for every square meter of surface area.

2.03.08 **Exposed Stonework**

Stonework, which is to be kept exposed, shall be as shown on drawing or described in the Schedule of Items. Especially especially skilled mason shall execute it. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or the Schedule of Items or instructions. A sample wall, 10sq.m. In area shall be built and approved by the Engineer and all works shall match with this sample.

2.03.08 **Hollow and Solid concrete block Masonry**

Hollow and solid concrete block shall conform to the requirement of I.S 2185. Hollow concrete block shall be sound, free from broken edges; free from cracks, honeycombing and other defects, which may give a defective work, impaired the required strength.

Dimensional stability: concrete masonry units shall be made of proper sizes and shape to suit the construction need and shall be in neutral of the following sizes:

The nominal size of concrete block /solid concrete block.

Length : 400,500,600.

Height : 200,100

Width : 50, 75,100,150,200,250,300.

In addition block shall be manufactured in half-length of correspondence to full length. Maximum tolerance of length shall be (±) 5mm and in height &with shall be ± 3mm.

The average crushing strength shall be determined as per I.S 2185 and shall be of Load bearing wall density of block shall be not less than 1500 kg /mm^3 and minimum average compressive strength of units shall be 3.5 to 7 N/mm^3 and minimum strength of individual unit shall be 2.8 to 5.6 for block density less than 1500 kg /mm^3 but not less than 1000 kg /mm^3 average compressive strength of units shall be 2.0 to5 N/mm^3 and minimum strength of individual unit shall be 1.6 to 4.0 N/mm^3

For non load bearing wall block density shall be not less than 1000kg / mm^3 and minimum average compressive strength of units shall be1.5 N/mm^3 and minimum strength shall be 1.2 N/mm^3

2.03.08 **Composite Masonry**

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

2.03.09 **Expansion & Separation Joints**

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified in the Schedule of Items. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

2.03.10 **Moldings, Cornices, Drip Course**

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.03.11 **Curing**

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.03.12 **Embedding of fixtures**

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

2.03.13 **Encasing of Structural Steel**

This shall be done by building masonry work, around flanges, webs etc. of steel members and filling the gap between steel and masonry by minimum 12 mm thick rich mortar. Encased members shall be wrapped with minimum 18G chicken wire mesh when shown on drawings or instructed by the Engineer, before plastering work.

The minimum lap in chicken wire mesh shall be 50 mm.

2.04.00 **Damp Proof Course**

Unless otherwise specified Damp-proof course shall be 40 mm or as per schedule thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

2.05.00 **Damp Proof Membrane**

Damp proof treatment using fiber or Hessian base bitumen felt shall be 6, 8 or 10 course treatments as specified in IS: 1609. The number of courses shall be as mentioned in the Schedule of Items. Sequence or work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after lying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150mm lap under slabs on grade.

3.00.00 **RATES**

Rates shall be unit rates for the complete work as detailed out in the Specification unless any particular portion is specifically excluded in the Schedule of Items.

4.00.00 **METHOD OF MEASUREMENT**

4.01.00 **Soling**

Soling of different types as enumerated in the Schedule of Items shall be measured on actual area basis. Deductions shall not be made for areas less than 0.1 Sq.M.

4.02.00 **Brick Edging**

Edging shall be measured on running length unless included in other relevant items.

4.03.00 **Masonry**

4.03.01 Thickness of brick walls shall be measured in nominal brick sizes.

4.03.02 For masonry work exceeding 150 mm in thickness, actual volume of work shall be measured and deductions for openings, lintels, sills, conduit ducts, pipes etc. shall be made. No opening less than 0.1 Sq.M. in area shall however be deducted.

4.03.03 No deductions shall be made for embedded fixtures nor any extra be paid for the mortar used for fixing or for necessary cutting of bricks.

4.03.04 For encasing of steel beams, columns etc. The sizes as shown on drawings shall be measured and deductions made for the volume of encased steel.

4.03.05 No extra payment shall be made for cutting of masonry units.

4.03.06 Walls 150 mm in thickness or less shall be measured for actual area of works and deductions made as in Clause 5.1.4.3.2.

4.03.07 Exposed brickwork using selected ordinary brick or face bricks for the exposed face shall be measured in area as an extra over the ordinary brickwork if so provided in the Schedule of Items. It shall be measured by volume including the composite backing if so provided in the Schedule. Deductions shall be made as described in Clause 5.1.4.3.2.

4.03.08 Reinforcements shall be measured and paid separately under relevant items in the schedule unless included in the items for masonry work.

Laps in wire mesh reinforcements shall not be measured. Reinforcing mesh shall be measured on actual area basis. Reinforcing bars shall be measured by weight.

The weight shall be arrived at on the basis of sectional weights as per I.S. No extra shall be paid for necessary modifications of existing dowels, if any, to tie up with the Contractor's work.

4.03.09 **Exposed Stonework**

Exposed Stonework using selected stone for exposed face shall be measured in area as an extra over ordinary stonework if so provided in the Schedule of Items. Deductions shall be made as described in Clause 5.1.4.3.2.

4.03.10 **Composite Masonry**

Composite masonry shall be measured for volume including backing if so provided in the Schedule of Items. If not, brickwork and stonework shall be measured separately and paid under relevant items.

4.03.11 **Expansion and Separation Joints**

Joints shall be measured for length or area for the complete work as shown on drawings including filler boards, sealant strips, sealing compounds, painting, cover etc. If so provided in the Schedule of Items unless any particular work is specifically excluded from the item.

4.03.12 **Mouldings, Cornice, Drip Course**

Mouldings, cornice, drip course unless indicated specifically under separate items shall be considered to be included in masonry items. However, cut in bricks or stone shall be neglected in measurements.

4.03.13 **Embedded Fixtures**

Inserts etc. Shall be measured by weight or by number and paid separately under relevant item in the Schedule of Items.

4.04.00 **Damp Proofing**

Damp proofing shall be measured and paid in net area. No deductions shall however be made for openings less than 0.1 sq. M. in area. No separate payment shall be made for preparation of base, formworks and additive for cast-in-situ damp proofing unless specified otherwise.

5.00.00 **I.S. CODES**

Some of the important relevant codes for this section are: -

IS : 1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
IS : 2185	:	Code Practice for hollow concrete block.
IS : 1597	:	Code of Practice for Construction of stone Masonry.
IS : 1609	:	Code of Practice for laying Damp-proof treatment Using bitumen felts.

IS : 2212	:	Code of Practice for Brickwork.
IS : 2250	:	Code of Practice for preparation and use of Masonry Mortar.
IS : 5134	:	Bitumen Impregnated Paper & Board.

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SECTION-XIII

TECHNICAL SPECIFICATION FOR PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIALS

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SECTION-XIII

TECHNICAL SPECIFICATION FOR PROPERTIES, STORAGE AND HANDLING OF COMMON BUILDING MATERIALS

1.00.00 SCOPE

The scope of this Section is to specify the properties, storage and handling of common building materials unless otherwise mentioned in drawings or schedule of items.

2.00.00 MATERIALS

a) **Bricks**

i) Common Burnt Clay Bricks : Bricks for general masonry work shall conform to IS: 1077-1970 and for face brick work shall conform to the specifications in IS: 2691-1972.

Bricks for general masonry work shall be of first class (Class-A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws warpage or nodules or free lime, having a frog 100mm in length 40 mm in width and 10mm to 20mm deep on one of its flat sides and omit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps boles etc.

Compressive strength shall be as per table-1 below. The bricks, when tested, shall have a minimum average compressive strength for various classes as given in Table-1 below. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any brick tested exceeds the upper limit for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified in Table-1 for the purpose of calculating the average compressive strength.

The average value of water absorption of bricks when tested shall not be more than 20% by weight.

All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chippage for face bricks shall be 6 mm at the edges and 10 mm for corners. The rating of efflorescence shall not be more than 'moderate'.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved sample shall be retained by the Engineer for future comparison and reference. The colour and texture of face bricks shall be up to the specification and defective bricks shall be removed immediately from site at the Contractor's own cost.

TABLE-1

Class Designation	Average compressive strength			
	Not less than		Less than	
	N/mm^2	(kg/cm^2)	N/mm^2	(kg/cm^2)
12.5(125)	12.5	(125)	15.0	150
10 (100)	10	(100)	12.5	125
7.5 (75)	7.5	(75)	10	100
5 (50)	5	(50)	7.5	75
3.5 (35)	3.5	(35)	5.0	50

ii) Fly Ash Lime Bricks (FLAG Bricks): The Fly Ash Lime Bricks (flag Bricks) shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. The bricks shall be solid and with or without frog on one of its flat side. Fly ash shall confirm to IS 3812.

Note : This item will be operated only for load bearing structure up to 2 storied and for non-load bearing walls 23cms thick for multi-storeyed buildings.

Bottom ash used as replacement of sand shall not have more than 12 % loss on ignition when tested.

Sand : Deleterious materials, such as clay and silt in the sand shall preferably be less than 5%.

Lime : Lime shall confirm to class 'C' hydrated lime of IS 712

Additives : Any suitable additive considered not detrimental to the durability of bricks may be used.

iii) **Clay Fly Ash Bricks :** The clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly ash shall conform to grade I or Grade II of IS 3812.

iv) **Mechanised Autoclave Fly Ash Lime Brick:** These bricks shall be machine moulded and prepared in plat by appropriate proportion of fly ash and lime. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and of 100/80 mm in length, 40 mm width and 10 to 20 mm deep one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

b) **Stone**

All stones shall be from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and shall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion and for laterite this percentage is 12%. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply. The compressive strength of common types of stones shall be as per Table below.

TABLE-2

Type of stone	Maximum Water Absorption Percentage by weight	Minimum Compressive Strength kg/sq.cm
Granite	0.5	1000
Basalt	0.5	400
Lime stone(Slab & Tiles)	0.15	200
Sand stone (Slab & Tiles)	2.5	300
Marble	0.40	500
Quartzite	0.40	800
Laterite(Block)	12	35

c) **Lime**

Lime shall be stone lime and conform to the specification Building Limes - IS: 712. Lime putty may be prepared from hydrant lime or quick lime. Hydrated lime shall be mixed with water to form putty and stored with reasonable care to prevent evaporation for at least 24 hours before use. Quick lime shall be shaked with enough water to make a cream, passed through a No. 0 Sieve and then stored with reasonable care to prevent evaporation for at least 7 days before use.

d) **Cement**

Cement used shall be ordinarily Portland cement conforming to Code for ordinary cement in IS: 269 and shall be fresh when delivered. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that the quality, quantity and freshness of cement are up to the specified standards. No complain later on regarding the cement supplied by the Owner shall be entertained and all rectification work on this account shall be done by the Contractor at his own expense. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

e) **Coarse Aggregates**

Coarse aggregates shall be as per IS:383 latest edition, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS:383 and shall be such as to produce a dense concrete of the specified proportions and strength and of consistency that will work readily into position without segregation.

f) **Sand**

Sand shall be hard, durables, clean and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrities, alkalis, salts, coal, mica or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosions to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded. Unless otherwise directed by the Engineer all sand shall pass through IS Sieve No. 240 and 15 to 35% of and for masonry mortar and 5 to 50% of sand for plaster shall pass through IS Sieve No. 30. Sand for concrete shall conform to IS: 383.

g) **Water**

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discolouration, efflorescence etc.

h) **Reinforcement**

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings which may impair proper bond. Structural steel shall conform to IS: 226. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432 Cold twisted steel bars shall conform to IS: 1786. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanised.

3.00.00 STORAGE AND HANDLING OF MATERIALS

a) Bricks

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded, to minimise breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stones

Stones shall be stored at site in manner approved by the Engineer. Dressed stone for wall facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

c) Lime

Lime shall be stored in weatherproof sheds.

d) Cement

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

e) Coarse and Fine Aggregates

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substances at any stage. Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

f) Reinforcement

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

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SECTION-XXV

TECHNICAL SPECIFICATION
FOR
PAINTING, WHITE WASHING AND POLISHING ETC.

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SECTION-XXV

TECHNICAL SPECIFICATION FOR PAINTING, WHITE WASHING AND POLISHING ETC.

1.00.00 SCOPE

This specification covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces on wood work, masonry, masonry surface with lime punning or white cement putty, concrete plastering, plaster of Paris punning, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, schedule or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Contractor shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting contractor shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing those results.

Before commencing painting, the painting contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations. Contractor shall keep record of number of coats of painting. Before applying second coat, the contractor shall obtain prior approval of Engineer in Charge

2.00.00 INSTALLATION

2.01.00 Materials

Materials shall be Grade-1 quality from well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint or one shade is obtained from the same

manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) **White Washing**

Preparation of Surface : Before new work is white washed, the surface shall be thoroughly brushed free from mortar droppings an foreign matters.

Preparation of Lime wash : The lime wash be prepared from fresh stone white lime (Natural or Dehradun quality) or fat lime, or a mixture of both as instructed by the Engineer, and shall conform to IS: 712 latest editions and shall be submitted to the Engineer for approval and approved sample shall be brought to site in unslaked condition. The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water, shall be added to each 10 cubic decimeter of the cream. The approximate quantity of water to be added in making the cream will be 5 liters of water to one kg of lime.

Indigo (Neel) up to 3 gm per kg of lime dissolved in water, shall then be added and stirred well. Water shall then be added at the rate of about 5 liters per kg. of lime to produce a milky solution.

Application: The white wash shall be applied with moonj brushes to the specified number of coats. The operation for each coat shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries.

Each coat shall be allowed to dry before the next coat is applied. Further each coat shall be inspected and approved by the Engineer-in-Charge before the subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on.

For new work, three or more coats shall be applied till the surface presents a smooth and uniform finish through which the plaster does not show. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

Protective Measures : Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

Measurements : Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals.

Measurements for Jambs, Soffits and Fills etc. for openings shall be as described earlier.

Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area.

Corrugated non-asbestos cement sheet	20%
Semi corrugated non-asbestos cement sheet	10%

Cornices and other such wall or ceiling features shall be measured along the girth and included in the measurements.

The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc exceeding 50 sq. cm. each with material similar in composition to the surface to be prepared.

The rate shall include all material and labour involved in all the operations described above.

b) **Colour Washing**

The mineral colours, not affected by lime, shall be added to white wash. Indigo (Neel) shall however, not be added. No colour wash shall be done until a sample of the colour wash of the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, it shall be redone by the contractor.

For new work, the priming coat shall be of white wash with lime or with whiting as specified in the description of the item. Two or more coats, shall then be applied on the entire surface till it represents a smooth and uniform finish.

For old work, after the surface has been prepared (as described above) a coat of colour wash shall be applied over the patches and repairs. Then a single coat, or two or more coats of colour wash, as stipulated in the description of the item shall be applied over the entire surface. The colour washed surface shall present a uniform finish.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

Other specifications as described eallier.

c) **Dry Distemper**

Materials : Dry distemper of required colour (IS 427) and of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer-in-Charge before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using6 decilitres (0.6 litre) of water per kg of distemper or as specified by the makers. Warm water shall preferably be used. It shall be allowed to stand for at least 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during use to maintain an even consistency.

Distemper shall not be mixed in larger quantity than is actually required for one day's work.

Preparation of Surface : Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth.

New plastered surfaces shall be allowed to dry completely, before applying, distemper.

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt, etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the resular coat of distemper is applied.

Priming Coat : A priming coat of whiting shall be applied over the prepared surface in case of new work, if so stipulated in the description of the item. No white washing coat shall be used as a priming coat for distemper.

The treated surface be allowed to dry before distemper coat is given.

Application : In the case of new work, the treatment shall consist of a priming coat of whiting followed by the application of two or more coats of distemper till the surface shows an even colour.

For old work, the surface prepared (as described before) shall be applied one or more coats of distemper till the surface attains an even colour.

The application of each coat shall be as follows :

The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash brushed shall not be allowed) in horizontal strokes followed immediately by vertical ones which together shall constitute one coat.

The subsequent coats shall be applied only after the previous coat has dried.

The finished surface shall be even and uniform and shall show no brush marks.

Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

After each day's work, the brushes shall be washed in hot water and hang down to dry. Old brushes which are dirty or caked with distemper shall not be used.

The specifications in respect of scaffolding and protective measures shall be as described before.

d) **Oil Emulsion (Oil Bound) Washable Distemper**

Materials

Oil emulsion (Oil Bound) washable distemper (IS 428) of approved brand and manufactures shall be used. The primers where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of the work, till this item of work has been completed and passed by the Engineer-in-Charge.

Preparation of the Surface

For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing & scrubbing. The surface shall then be allowed to dry for that at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

Application

Priming Coat : The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described before.

Note: If the wall surface plastered has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied.

Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surface if required to be distempered before a period of six months shall be given a coat of alkali resistant priming Paint confirming to IS 109 and allowed to dry for atleast 48 hours before distempering is commenced.

For old work no primer coat is necessary.

Distemper Coat : For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.

15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hang down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

The specifications in respect of scaffolding, protective measures shall be as described before.

e) **Cement Primer Coat**

Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on non-asbestos cement surfaces before oil emulsion distemper Paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalies present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper Paints.

Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion Paints etc.

Preparation of the Surface : The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any uneveness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

Application : The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before oil emulsion Paint is applied.

The specifications in respect of scaffolding, protective measures shall be as described before.

f) **Cement Paint**

Material : The cement Paint shall be (confirming to IS 5410) of approved brand and manufacturer.

The cement Paint shall be brought to the site of work by the contractor in its original containers is sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of the work has been completed and permission obtained from the Engineer-in-Charge.

Preparation of the Surface : For new work, the surface shall be thoroughly cleaned of all mortar dropping, dirt dust, algae, grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement Paint shall be applied over patches after wetting them thoroughly.

Preparation of Mix : Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not vice versa. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously.

The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities.

In case of cement Paint brought to in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

Application : The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The salutation shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the days work.

The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

Precaution : Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces.

If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

The specifications in respect of scaffolding and protective measures shall be as described before. The coefficient for cement paint on RCC Jalli shall be 2 x (for painting all over).

g) **Exterior Painting on Wall**

Material : The paint shall be (Textured exterior paint / Acrylic smooth exterior paint / premium acrylic smooth exterior paint) of approved brand and manufacture.

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The material shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained form the Engineer-in-Charge.

Preparation of Surface : For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection before painting is commenced.

Application :

Base coat of water proofing cement paint – All specifications in respect of base coat of water proofing cement paint shall be as described before.

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with portable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the

manufacturer's instructions & directions of the Engineer-in-Charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

The specifications in respect of scaffolding and protective measures shall be as describe before.

3.00.00 PAINTING

Materials

Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed Paint (Exterior grade) as received from the manufacturer without any admixture shall be used.

If for any reason, thinning is necessary in case of ready mixed paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used.

Approved paints, oil or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empties shall not be removed from the site of the work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

Commencing Work

Painting shall not be started until the Engineer-in-Charge has inspect the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work. Painting of external surface should not be done in adverse weather condition like hail storm and dust storm.

Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the Paint work being started.

Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

Application

Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also, the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over the Paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, to or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

Where so stipulated, the painting shall be done by spraying. Spray machine used may be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by through ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

No left over Paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

No hair marks from the brush or clogging of Paint puddles in the corners of panels, angles of moulding etc. shall be left on the work.

In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no Paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need to be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

The additional specifications for primer and other coats of Paints shall be as according to the detailed specifications under the respective headings.

Brushes and Containers

After work, the brushes shall be completely cleaned of Paint and linseed oil by rinsing with turpentine. A brush in which Paint has dried up is ruined and shall on no account be used for painting work. The containers when not in use, shall be kept closed and free from air so that Paint dose not thicken and also shall be kept safe from dust. When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

Measurements

The length and breadth shall be measured correct to a cm. The area shall be calculated in the sqm. (correct to two places of decimal), except otherwise stated.

Small articles not exceeding 10 sq. decimeter (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

Note: Components of trusses, compound girders, stanchions, lattices and similar work shall, however, be given in sqm. irrespective of the size or girth of members. Priming coat of painting shall be included in the work of fabrication.

In measuring painting, varnishing, oiling etc. of joinery and steel work etc. The coefficients as indicated in following tables shall be used to obtain the area payable. The coefficients shall be applied to the areas measured flat and not girthed.

Table 1
Equivalent Plain Areas of Uneven surface

Sl. No.	Description of Work	How measured	Multiplying Coefficients
I.	**Wood Work Doors, Windows etc.**		
1.	Panelled or framed and braced doors, windows etc.	Measured flat (not girthed including)	1.30 (for each side)
2.	Ledged and battened or ledged, battened and braced doors, windows etc.	Chowkhat or frame, Edges, chocks, cleats, etc. shall be deemed to be included in the item.	1.30 (for each side)
3.	Flush doors etc.	. --- do ---	1.20 (for each side)
4.	Part paneled and part glazed or gauzed doors, window etc. (Excluding painting of wire gauze portion)	. --- do ---	1.00 (for each side)
5.	Fully glazed or gauzed doors, windows etc. (Excluding painting of wire gauze portion)	. --- do ---	0.80 (for each side)
6.	Fully venetioned or louvered doors, windows etc.	. --- do ---	1.80 (for each side)
7.	Trellis (or Jaffri) work one way or two way	Measured flat overall, no deduction shall be made for open spaces, supporting members shall not be measured separately	2.00 (for painting all over)
8.	Carved or enriched work	Measured flat	2.00 (for each side)
9.	Weather boarding	Measured flat (not girthed supporting frame work) shall not be measured separately	1.20 (for each side)
10.	Wood single roofing	Measured flat (not girthed)	1.10 (for each side)
11.	Boarding with cover fillets and match boarding	Measured flat (not girthed)	1.05 (for each side)
12.	Tile and slate battening	Measured flat overall no deductions shall be made for open spaces	0.08 (for painting all over)

Sl. No.	Description of Work	How measured	Multiplying Coefficients
II.	**Steel Work Doors, Windows etc.**		
13.	Plane sheeted steel doors or windows	Measured flat (not girthed) including frame edges etc.	1.10 (for each side)
14.	Fully glazed or gauzed steel doors and windows (Excluding painting of wire gauze portion)	. --- do ---	0.50 (for each side)
15.	Part paneled and partly glazed or gauzed doors and windows etc. (Excluding painting of wire gauze portion)	. --- do ---	0.80 (for each side)
16.	Corrugated sheeted steel doors or windows	. --- do ---	1.25 (for each side)
17.	Collapsible gates	. --- do ---	1.50 (for painting all over)
18.	Rolling shutters of interlocked laths	Measured flat	1.10 (for each side)

Sl. No.	Description of Work	How measured	Multiplying Coefficients
III.	**General**		
19.	Expanded metal, hard drawn steel wire fabric of approved quality, grill works and gratings in guard bars, balustrades, railing partitions and MS Bars in windows frames.	Measured flat overall; no deduction shall be made for open spaces; supporting members shall not be measured separately	1.00 (for Paint all over)
20.	Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel	. --- do --- (See note no. 12)	1.00 (for Paint all over)
21.	Corrugated iron sheeting in roofs, side cladding etc.	. --- do --- Measured flat (not girthed)	1.14 (for each side)
22.	AC corrugated sheeting in roofs, side cladding etc.	. --- do ---	1.20 (for each side)
23.	AC semi corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plane sheets	. --- do ---	1.10 (for each side)
24.	Wire gauze shutters including painting of wire gauze	. --- do ---	1.00 (for each side)

Explanatory Notes for Table 1

1. Measurement for doors windows etc., shall be taken flat (and not girthed) over all including chowkhuts or frames, where provided. Where Chowkhuts or frames are not provided, the shutter measurements shall be taken.

2. Where doors, windows etc., are of composite types, different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.

3. The coefficients for doors and windows shall apply irrespective of the size of frames and shutter members.

4. In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.

5. When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one or the other type of finish as ordered by the Engineer-in-Charge and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

6. In the case where shutters are fixed on both faces of the frames, the measurement for he door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter only excluding the frame.

7. Where shutters are provided with clearance at top or / and bottom each exceeding 15 cm height, such openings shall be deducted from the overall measurements and relevant coefficient shall be applied to obtain the area payable.

8. Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel vertical. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.

9. Coefficients for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for the painting guide rails, rollers, fittings etc.

10. Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.

11. The measurements of guard bars, expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings, when fixed in frame work, painting of which is once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.

12. For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisade do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top standards when the letter are higher than the top rails or the palisades.

Width of moulded work of all other kinds, as in hand rails, cornices, architraves shall be measured by girth.

For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas will be measured in sqm. and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes, etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual.

Flag staffs, steel chimneys, aerial masts, spires and other such objects requiring special scaffolding shall be measured separately.

Precautions

All furnitures, fixtures, glazing, floors etc. shall be protected by covering and stains, smears, splashing, if any shall be removed and any damages done shall be made good by the contractor at his cost.

Rate
Rates shall include cost of all labour and materials involved in all the operations described above and in the particular specifications given under the several items

4.00.00 **PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES**

Primer

The primer for wood work, iron work or plastered surface shall be as specified in the description of item.

Primer for plaster / wood work / Iron & Steel / Aluminium surfaces shall be as specified below.

Table-2

Sl. No	Surfaces	Primer to be used
1.	Wood work (hard and soft wood)	Pink conforming to IS 3536
2.	Resinour wood and plywood	Aluminium primer confirming to IS 3585
3.	(A) Aluminium and light alloys	Zinc chromate primer confirming to IS 104
	(B) Iron, Steel and Galvanized steel	Red Oxide Zinc chromate Primer confirming IS 2074
4.	Cement/Concrete/RCC/brickwork, Plastered surfaces, non-asbestos surfaces to receive Oil bound distemper or Paint finish.	Cement primer confirming to IS 109

The primer shall be ready mixed primer of approved brand and manufacture.

Where primer for wood work is specified to be mixed at site, it shall be prepared from a mixture of red lead, white lead and double boiled linseed oil in the ratio of 0.7 kg : 0.7 kg : 1 litre.

Where primer for steel work is specified to be mixed at site, it shall be prepared from a mixture of red lead, raw linseed oil and turpentine in the ratio of 2.8 kg :1 litre : 1 litre.

The specifications for the base vehicle and thinner for mixed on site primer shall be as follows:

i) **White Lead :** The white lead shall be pure and free from adulterants like barium sulphate and whiting. It shall confirm to IS 103.

ii) **Red Lead:** This shall be in powder form and shall be pure and free from adulterants like brick dust etc. It shall confirm to IS 102.

iii) **Raw Linseed Oil:** Raw linseed oil shall be lightly viscous bit clear and of yellowish colour with light brown tinge. Its specific gravity at a temperature of 30 degree C shall be between 0.923 and 0.928.

Note: The oil shall be mellow and sweet to the taste with very little small. The oil shall be of sufficiently matured quality. Oil turbid or thick, with acid and bitter taste and rancid odour and which remains sticky for a considerable time shall be rejected. The oil shall confirm in all respects to IS 75. The oil shall be of approved brand and manufacture.

iv) **Double Boiled Linseed Oil:** This shall be more viscous than the raw oil, have a deeper colour and specific gravity between 0.931 and 0.945 at a temperature of 30 degree C. It shall dry with a glossy surface. It shall confirm in all respects to IS 77. The oil shall be of approved brand and manufacture.

Turpentine : Mineral turpentine i.e. petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleoresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall confirm to IS 533.

All the above materials shall be approved manufacture and brought to site in their original packing in sealed condition.

4.01.00 **Preparation of Surface**

4.01.01. **Wooden Surface :** The wood work to be painted shall be dry and free from moisture. The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material confirming to IS 345 with same shade as Paint shall be used where specified. The surface treated for knotting shall be dry before paint is applied. After obtaining approval of Engineer-in-Charge for wood work, the priming coat shall be applied before the woo work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

4.01.02. **Iron and Steel Surface :** All rust and scales shall be removed by scrapping or by brushing with wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface.

If the surface is wet, it shall be dried before priming coat is undertaken.

4.01.03. **Plastered Surface :** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations shall be filled up with plaster of paris and rubbed smooth.

Application

The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described before.

Treatment on Steel for Aggressive Environment

A second coat of ready mixed red oxide zinc chromate primer may be applied where considered necessary in aggressive environment such as near Industrial Establishment and Coastal regions where the steel members are prone to corrosion. The second coat (which shall be paid for separately) is to be applied after placing the member in position and just before applying Paint. The second coat of primer is not necessary in case of painting with synthetic enamel Paint as it is applied over and under coat of ordinary Paint.

Painting Priming Coat On Wood, Iron Or Plastered Surfaces

Synthetic Enamel

Paint, suitable for painting over G.S. sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered G.S sheets shall be painted with a priming coat of one coat of redoxide zinc chromate Paint. Primer shall be applied before fixing sheets in place.

Preparation of Surface

Painting New Surface : The painting of new G.S. sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sqm. to 280 sqm. of area and is applied for ensuring proper adhesion of Paint. The painting with the mordant solution will be paid for separately.

Before painting on new or weathered G.S. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and surface washed and dried and rusted surface shall be touched with synthetic enamel paint of approved brand, manufacturer and shade.

Painting Old Surface : If the old Paint is firm and sound, it shall be cleaned and grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint.

If the old Paint is blistered and flaked, it shall be completely removed as described before. Such removal shall be paid for separately and painting shall be treated as on new work.

Application

The number of coats to be applied shall be as in the description of item. In the case of C.G.S. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning.

The second or additional coats shall be applied when the previous coat has dried.

5.00.00 **PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS**

The primer shall be prepared on site or shall be of approved brand and manufacture as specified in the item.

Paint shall be anti-corrosive bitumastic Paint, aluminium Paint or other type of Paint as specified in the description of the item.

Painting New Surface

Preparation of Surface : The surface shall be prepared for priming coat as described earlier.

Application : The number of coat of painting over the priming coat shall be as stipulate in the description of the item. The application of Paint over priming coat shall be carried out as specified above.

Measurements : Measurements will be taken over the finished line of pipe including specials etc. in running metres, correct to a cm.

Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

Rate : The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

Painting on Old Surface

Preparation of Surface : If the old Paint is firm and sound, it shall be cleaned and grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint.

If the old Paint is blistered and flaked, it shall be completely removed as described before. Such removal shall be paid for separately and painting shall be treated as on new work.

Application : The specifications for application shall be as described earlier.

Measurements : Measurements will be taken over the finished line of pipe including specials etc. in running metres, correct to a cm.

Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

Rate : The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

6.00.00 PAINTING WITH WOOD PRESERVATIVE

Oil type wood preservative of specified quality and approved make, confirming to IS 218 shall be used. Generally, it shall be creosote oil type-I or anthracene oil.

Painting on New Surface

Preparation of Surface : Painting shall be done only when the surface is perfectly dry to permit of good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted. All roughness shall be sand papered and cleaned.

Application : The preservative shall be applied liberally with a stout brush and not daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the wood work. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second coat shall be applied in the same manner as the first coat. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

Painting on Old Surface

The work shall be done in the same manner as on new surface except that only one coat shall be done.

7.00.00 COAL TARRING

Coal tar of approved manufacture confirming to IS 290 shall be used. The tar, to every litre of which 200 gm of unslaked lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added to it slowly at the rate of one part of kerosene oil to six or more parts by volume and stirred thoroughly. The addition of lime is for preventing the tar from running.

Coal Tarring on New Surface

Preparation of Surface : This shall be done as specified in 4.01.00 except that sand papering is not necessary. Where iron work is to be painted it shall be free from scales and rust before painting.

Application : The mixture shall be applied as hot as possible with a brush. The second coat shall be applied only after the first coat has thoroughly dried up. Where possible, the article to be tarred, shall be dipped in the hot mixture for better results. The quantity of tar to be used for the first or second coat shall be not less than 0.16 and 0.12 litre per sqm respectively. Thinning with kerosene oil shall be suitable done to ensure this.

Coal Tarring on Old Surface

The work shall be done in the same manner as specified above (Coal Tarring on New Surface) except that only one coat using 0.12 litre per sqm. area shall be done.

8.00.00 **SPRAY PAINTING WITH FLAT WALL PAINT ON NEW SURFACE**

The work shall include a priming coat of 'Distempering Primer' or 'Cement Primer' as specified in the description of the item. Flat wall Paint shall normally be applied on walls 12 months after their completions, in which case Distemper primer will suffice. If the walls are to be painted earlier, the primer coat shall consist of cement primer.

The primer and the flat wall Paint shall be of approved brand and manufacture and of the required shade.

Preparation of the Surface : The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any uneveness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

Application

Priming Coat : The specified primer shall be painted or sprayed over the surface in an even and uniform layer.

Painting Coats : When the surface is dry, the spray painting with the wall Paint in uniform and even layers will be done to the required number of coats. Each coat shall be allowed to dry overnight and lightly rubbed with every fine grade of sand paper and loose particles brushed off before the next coat is sprayed.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted.

At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.

If after the final coat of wall Paints, the surface obtained is not upto the mark, further one or more coats as required shall be given after rubbing down the surface and dusting off all loose particles to obtain a smooth and even finish.

If the primer or wall Paint gets thickened during the application, it shall be thinned suitably with the thinner recommended by the manufacture.

Adequate ventilation shall be provided to disperse spray fumes. Fitments and floor shall be protected from the spray.

9.00.00 SPRAY PAINTING WITH FLAT WALL PAINT ON OLD SURFACE

Where the old Paint is in sound condition, renewal shall be carried out as described below, otherwise the old Paint shall be completely stripped and spray painting shall be carried out as over new work. Such removal shall be paid for separately.

The flat wall Paint shall be of approved brand and manufacture and of required shade.

Preparation of Surface

The surface shall be washed to remove dust and dirt. A mild detergent solution like soap water shall be used for washing and surface shall also be rubbed down lightly with abrasive paper when dry. Any patches appearing on the surface shall first be touched up with a coat of Paint. These shall be allowed to dry and then rubbed down tightly.

Application

The paint shall then be applied with spraying machine in uniform and even layer. A second coat shall be applied if considered necessary by the Engineer-in-Charge but only after the first coat is complete dry and hard.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted. At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they result in variable spray patterns, runs, sags and uneven coats.

10.00.00 WALL PAINTING WITH PLASTIC EMULSION PAINT

The plastic emulsion Paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These Paints are to be used on internal surfaces except wooden and steel.

Plastic emulsion Paint as per IS 5411 of approved brand and manufacture and of the required shade shall be used.

Painting on New Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, morter droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commended.

Application : The number of coats shall be as stipulated in the item. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Precautions

a) Old brushes if they are to be used with emulsion Paints, should be completely dried of turpentine or oil Paints by washing in warm soap water.

   Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the Paint from hardening on the brush.

b) In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.

c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.

d) Washing of surfaces treated with emulsion Paints shall not be done within 3 to 4 weeks of application.

Painting on Old Surface

Preparation of Surface *:* This shall be done, generally as specified in 4.01.01 except that the surface before application of Paint shall be flattened well to get the proper flat velvety finish after painting.

Application : The number of coats to be applied shall be as in description of item. The number of coats shall be as stipulated in the item. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surface to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

Except the above the thinning with water shall not normally be required.

11.00.00 PAINTING WITH SYNTHETIC ENAMEL PAINT

Synthetic Enamel Paint (confirming to IS 2933) of approved brand and manufacture and of the required colour shall be used for the top coat and an under coat of ordinary Paint of shade to match the top coat as recommended by the same manufacture as far the top coat shall be used.

Painting on New Surface

Preparation of Surface *:* Preparation of surface shall be as specified in 4.01.00 as the case may be.

Application : The number of coats including the undercoat shall be as stipulated in the item.

a) **Under Coat :** One coat of he specified ordinary Paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.

b) **Top Coat:** Top coat of synthetic enamel Paint of desired shade shall be applied after the under coat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

Other details shall be as specified in 'EXTERIOR PAINTING ON WALL' as far as they applicable.

Painting on Old Surface

Preparation of Surface : Where the existing Paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified Paint. The surface shall again be rubbed and made smooth and uniform.

If the old Paint is blistered and flaked it will be necessary to completely remove. Such removal shall be paid for separately and the painting shall be treated as on new surface.

Painting : The number of coats as stipulated in the item shall be applied with synthetic enamel Paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

12.00.00 PAINTING WITH ALUMINIUM PAINT

Aluminium Paint shall be (confirming to IS 2339) of approved brand and manufacture. The Paint comes in compact dual container with the paste and the medium separately.

The two shall be mixed together to proper consistency before use.

Preparation of Surface

Steel Work (New Surfaces) : All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper. The surface shall be thoroughly cleaned of dust.

C.G.S. Sheets (New Surfaces) : The preparation of surface shall be as specified in 'PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS on Painting New Surface'.

Steel Work or C.G.S. Sheets (Old Surfaces) : The specifications shall be as described in 'PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS on Painting Old Surface'.

Application

The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted off before the next coat is applied. The finished surface shall present an even and uniform appearance.

As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the Paint during used. Also the Paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

13.00.00 PAINTING WITH ACID PROOF PAINT

Acid proof Paint of approved brand and manufacture and of the required shade shall be used.

Preparation of surface and application shall be as specified under 11.00.00 for new/old surface as the case may be.

Other details shall be as specified in 3.00.00 as far as they applicable

14.00.00 PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT

Ready mixed Paint (confirming to IS 158) shall be of approved brand and manufacture. It shall be black, lead free, acid-alkali-heat-water resistant.

Preparation of surface and application shall be as specified in 13.32 for Painting on new or old surfaces as the case may be.

The drying time between consecutive coats, however, shall be not less than 3 hours.

Other details shall be specified in 3.00.00 as far as applicable.

15.00.00 FLOOR PAINTING

Floor Paint of approved brand and manufacture and of the required colour shall be used.

Preparation of Surface

All dirt, grease shall be removed from the floor by wiping with rags, soaked in turpentine and scraping where necessary and then washing with warm water, containing caustic soda or washing soda in solution. The floor should then be rinsed thoroughly with water and dried. Cracks and holes shall then be filled with specified filler as recommended by the manufacture and rubbed smooth.

It should be noted that the painting with floor paints shall not be done over concrete surfaces less than two years old.

Old surface shall be prepared as specified in 'PAINTING WITH SYNTHETIC ENAMAL PAINT, Painting on Old Surface, Preparation of Surface'.

Application

The number of coats as in the description of the item shall be applied. Each coat shall be allowed to dry for not less than 24 hours before the next coat is applied. The flooring should not be brought into use for a week after final coat so that the painted surface can thoroughly harden.

16.00.00 **VARNISHING**

Ordinary copal varnish or superior quality spray varnish shall be used. The work includes sizing of transparent wood filler.

Varnish (confirming to IS 347 for the finishing and undercoats shall be of the approved manufacturer.

Varnishing on New Surfaces

Preparation of Surface : New wood work to be varnished shall have been finished smooth with a carpenter's plan. Knots shall be cut to a slight depth. Cracks and holes shall be cleaned of dust. The knots, cracks etc. shall then be filled in with wood putty made as follows:

On a piece of wood say 20 x 15 cm face and on the side where cross grains appear, a small quantity of glue size shall be poured and surface scraped with the edge of a fine carpenter's chisel. Very fine wood powder shall be mixed with the glue and the stiff paste thus formed shall be used for the filling.

The fillings when dry shall be rubbed down with a carpenter's file and then the entire surface shall be rubbed down perfectly smooth with medium grained and fine sand papers and wiped with dry clean cloth so that it presents uniform appearance. In no case shall sand papers be rubbed across the grains, as in this case even the finest marks will be visible when the varnishing is applied.

Sizing or Transparent Wood Filler Coat : The surface shall then be treated with either glue sizing or with transparent wood filler coat as stipulated in the description of item.

a) **Sizing :** When sizing is stipulated, an application of thin clean size shall be applied hot on the surface. When dry, the surface shall be rubbed down smooth with sand paper and cleaned. It shall then be given another application of glue size nearly cold. The sized wood work shall again be rubbed down smoothly with fine sand paper and cleaned. The surface shall be perfectly dry and all dust shall be removed not only from the surface but also from the edges and joints before varnishing is commenced. If the wood work is to be stained, the staining colour shall be mixed with the second coat of the size which must be applied evenly and quickly keeping the colour on the flow.

Any jointing up with work already dry will show badly. The object of application of the glue size is to seal the pores in wood to prevent absorption of the oil in the varnish.

Glue sizing is inadvisable on floors, table tops and other horizontal surfaces likely to carry wet household untensils which are likely to disturb the size coatings and thus expose bare wood.

Where glue sizing is omitted to be done the rate for the work shall be suitably reduced.

b) **Transparent Wood Filler Coat :** Where instead of glue sizing, transparent wood filler application is stipulated in the item, then the surface prepared as described earlier, shall be given as application of the application of the filler with brush or rag in such a way that the filler fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours. Then it shall be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

Application of Varnish : The number of coats to be applied shall be as stipulated in the description of the item.

The undercoat shall be with a flatting varnish. This dries hard and brittle and when cut and rubbed down to produce a smooth surface enhance the gloss of the finishing varnish. The top coat shall be given with stipulated brand of finishing varnish.

The varnish shall be applied liberally with a full brush and spread evenly with short light strokes to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, letter being finished on the upstrokes so that varnish, as it sets, flows down and eliminates brush marks, the above process will constitute one coat. If the surface is horizontal, varnished shall be worked in every direction, with light quick strokes and finish in one definite direction so that it will set without showing brush marks, in handling and applying varnish care should be taken to avoid forming froth or air bubbles. Brushes and containers shall be kept scrupulously clean.

Rubbing down and flatting the surface shall be done after each coat except the final coat with fine sand paper.

The work shall be allowed to dry away from droughts and dump air. The finished surface shall then present a uniform appearance and fine glossy surface free from streaks, blister etc.

Any varnish left over in the small container shall not be poured back into the stock tin, as it will render the latter unfit for use.

Special fine haired varnishing brushes shall be used and not ordinary Paint brushes. Brushes shall be well worn and perfectly clean.

Other details shall be as specified in 3.00.00 as far as they are applicable.

Varnishing on Old Surface

Preparation of Old Surface : If the old varnished surface is firm and sound it shall be cleaned of grease and dirt with turpentine and then rubbed with wet sand paper until the surface is clean and smooth. It shall be dried and wiped clean with a soft cloth. Knots, holes and cracks shall be stopped as specified in ‘Varnishing on New Surfaces, Preparation of Surface’. The entire surface shall then be rubbed down smooth with sand paper and wiped clean.

If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish and such removal shall be paid for separately outside the rate for varnishing. Future the varnishing itself will have to be done like new work and will be paid for as such.

Application : The specification shall be same as described in ‘Application of Varnish’ as far as applicable except that the coats to be applied will be with the stipulated quality of varnish for finishing coat.

Other details shall be as specified in 3.00.00 as far as they are applicable.

17.00.00 **FRENCH SPIRIT POLISHING**

Pure shellac confirming to IS 16 varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade. Ready made polish confirming to IS 348 can also be used.

Polishing New Surface

Preparation of Surface : The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 Kg of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

Application : The number of coats of polish to be applied shall be as described in the item.

A pad of wooden cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to given an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

Other details shall be as specified in 3.00.00 as far as they are applicable.

Polishing Old Surface

Preparation of Surface : If the old polished surface is not much solid it shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sand paper.

If the old polished surface is much soiled then it will be necessary to remove the entire polish and such removal shall be paid for separately outside the rate of polishing. Further the polishing itself will have to do done like new work and will be paid for as such.

Application : The specifications shall be same as described above and as far as applicable.

Other details shall be as specified in 3.00.00 as far as they are applicable.

18.00.00 **EPOXY COATING/PAINTING**

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers specification:

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete should be filled with levelling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 830 - 45 Parts by weight

HARDENER BY 850 -15 Parts by weight

SILICA FLOUR - 20 Parts by weight

FLOW CONTROL - 2 Parts by weight
AGENT

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

18.01.00 **Protection**

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

18.02.00 **Cleaning up**

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

19.00.00 **ACCEPTANCE CRITERIA**

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

20.00.00 **RATES**

Rates shall be unit rates for complete items described in the Schedule of Items. No extra payment will be made for preparation of surface before painting or for cleaning up after the work is complete.

21.00.00 **METHOD OF MEASUREMENT**

a) All structural steelwork whose any or all faces are to be painted shall be measured and paid according to Table-1.

b) Painting or whitewashing to concrete or masonry shall be measured and on the area painted. For measurement of openings whose jambs, sills, soffits etc. are to be painted the following procedure shall be followed:

i) For openings up to 0.5 sq.m. but not exceeding 3.0 sq.m. each deductions shall be made for half the area of openings and no additions shall be made for jambs, sills, etc.

ii) For openings exceeding 0.5 sq.m. but not exceeding 3.0 sq.m. each deductions shall be made for half the area of openings, and no additions shall be made for jambs, sills etc.

iii) For openings exceeding 3.0 sq.m. each, deductions shall be made for the whole area, and additions shall be made for the jambs, sills soffits, reveals etc.

c) For openings, pipes, sleeves etc. whose sides are not finished no deductions shall be made for openings etc. upto 0.1 sq.m. in area each and full deductions shall be made for all openings above 0.1 sq.m. in area each.

d) No extra shall be paid for painting etc. done around openings, sleeves, pipes, ducts, inserts, etc.

e) No extra payment shall be made for painting, etc. on wall features such as grooves, ducts, beads, projections, cornices, etc. unless give different finish or otherwise specified in the "Schedule of Items". The actual area of the features shall be girthed and included in the wall measurements.

f) For painting of uneven surfaces in doors, windows, ventilators, louvers, guard bars, balustrades, gratings, railings, gates, etc. equivalent plain areas shall be measured as given in Clause 17.2 (Table II) of IS:1200.

g) Corrugated surfaces shall be measured flat as fixed and not girthed. The quantities as measured shall be multiplied by the following factors to get equivalent plain area :

i) Corrugated steel sheets - shall be multiplied by 1.14.

ii) Corrugated asbestos sheets with large corrugations shall be multiplied by 1.20

iii) Semi-corrugated asbestos cement sheets shall be multiplied by 1.10.

iv) Any other non-standard corrugated surfaces shall be measured as decided by the Engineer.

h) For painting pipes for sanitary and plumbing work, measurement shall be made on actual work done in R.M. for different diameters. Measurements shall be along the central lines of pipes laid. No deductions or additions shall be made for valves, fittings, etc.

i) Unless specifically stated on the schedule of items, all painting, varnishing or polishing of wood shall be measured and paid on the area treated. For measurement of uneven surfaces, equivalent Main area shall be measured as per Clause 17.2 (Table II) of IS: 1200.

22.00.00 **I. S. CODE**

Important relevant IS Codes for this Sections are listed below :

IS: 348	:	Specification for French polish
IS: 427	:	Specification for Distemper, dry colour as required.
IS: 428	:	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	:	Code of Practice for painting of ferrous metal in buildings.
IS: 2338 (I & II)	:	Code of Practice for finishing of wood and wood based materials.
IS: 2339	:	Specification for Aluminium Paints for general purposes in dual containers.
IS: 2395	:	Code of Practice for painting concrete, masonry and plaster surface.
IS: 2932	:	Specification for enamel, synthetic, exterior, type-I.
IS: 5410	:	Specification for cement paint, colour as required.

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SECTION-XV

QUALITY ASSURANCE AND INSPECTION FOR CIVIL AND STRUCTURAL WORK

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SECTION-XV

QUALITY ASSURANCE AND INSPECTION FOR CIVIL AND STRUCTURAL WORK

1.00.00 INTRODUCTION

1.01.00 This part of the specification covers the sampling, testing and quality assurance requirement (including construction tolerances and acceptance criteria) for all civil and structural works covered in this specification.

1.02.00 This part of the technical specification shall be read in conjunction with other parts of the technical specifications, general technical requirements & erection conditions of the contract. Wherever IS code or standards have been referred they shall be the latest revisions.

1.03.00 The rate for respective items of work or price shall include the cost for all works, activities, equipment, instrument, personnel, material etc. whatsoever associated to comply with sampling, testing and quality assurance requirement including construction tolerances and acceptance criteria and as specified in subsequent clauses of this part of the technical specifications. The QA and QC activities in all respects as specified in the technical specifications/ drawings / data sheets / quality plans / contract documents shall be carried out at no extra cost to the owner.

1.04.00 The contractor shall prepare detailed construction and erection methodology scheme which shall be compatible to the requirements of the desired progress of work execution, quality measures, prior approvals if any and the same shall be got approved by the Engineer. If required, work methodology may be revised/ reviewed at every stage of execution of work at site, to suit the site conditions by the contractor at no extra cost to the owner.

2.00.00 QUALITY ASSURANCE PROGRAMME

2.01.00 The contractor shall adopt suitable Quality Assurance Programme (QAP) to ensure that the equipments and services under the scope of contract whether manufactured or performed within contractor's works or at his sub-contractor's premises or at the OWNER'S site or at any other place of work are in accordance with the specifications. Such QAP shall be outlined by the contractor and shall be finally accepted by the OWNER or their authorized representative after discussions before the start of work. The QAP shall be generally in line with IS/ISO Systems.

The contractor shall furnish complete QA & QC programme for the work envisaged which may include the following

- Organization structure for the management and implementation of the proposed quality assurance programme
- Quality System Manual
- Design Control System
- Documentation and Data Control System
- Qualification data / details for Contractor's key personnel
- The procedure for purchase of materials, parts, components and selection of subcontractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased, etc.
- System for shop manufacturing and site erection controls including process, fabrication and assembly
- Control of non-conforming items and system for corrective actions and resolution of deviations
- Inspection and test procedure both for manufacture and field activities.
- Control of calibration and testing of measuring testing equipment.
- System for Quality Audits
- System for identification and appraisal of inspection status
- System for authorizing release of manufactured product to the OWNER
- System for handling, storage and delivery.
- System for maintenance of records
- Quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of work/ equipment/component.

3.00.00 **QA AND QC MANPOWER**

3.01.00 The contractor shall nominate one overall QA coordinator for the contract detailing the name, designation, contact details and address at the time of post bid discussions. All correspondence related to Quality Assurance shall be addressed by the contractor's QA coordinator to OWNER. OWNER shall address all correspondence related to Quality issues to the contractor's QA coordinator. The contractor's QA coordinator shall be responsible for co-ordination of Quality activities between various divisions of the contractor and their sub-vendors on one hand & with OWNER on the other hand.

3.02.00 The contractor shall appoint a dedicated, experienced and competent QA&QC in-charge at site, preferably directly reporting to the Project Manager, supported as necessary by experienced personnel, to ensure the effective implementation of the approved QAP. An indicative structure of contractor's QA&QC manpower required to be deployed at site is enclosed at Annexure-I. Based on the finalized L-2 network and the approved Field Quality plan, the contractor shall finalize and submit a deployment schedule of QA&QC personnel along with their details to OWNER for approval/ acceptance and further shall ensure their availability well before the start of the concern activity.

3.03.00 The QA&QC in-charge shall have the organizational freedom and authority to implement the requirements of these quality assurance arrangements, free from commercial and programme restraints. The QA&QC setup of the contractor shall consist of qualified and experienced Civil, Electrical, Mechanical Engineers and Laboratory assistants with their supporting staff both at their works and site.

3.04.00 The deployment of man power for QA & QC set up shall be affected on the basis of agreed manpower deployment schedule, which shall be prepared by the contractor based on the L-2 network and the same shall be submitted to the engineer-in-charge for acceptance.

4.00.00 **SAMPLING AND TESTING OF CONSTRUCTION MATERIALS**

4.01.00 The method of sampling for testing of construction materials and work / job samples shall be as per the relevant IS / standards / codes and in line with the requirements of the technical specifications / quality plans. All samples shall be jointly drawn, signed and sealed wherever required, by the contractor and the engineer or his authorized representative.

4.02.00 The contractor shall carry out testing in accordance with the relevant IS / standards/codes and in line with the requirements of the technical specifications/quality plans. Where no specific testing procedure is mentioned, the tests shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer. All testing shall be done in the presence of the engineer or his authorized representative.

4.03.00 Before execution of any civil work the contractor shall conduct full-scale suitability tests on various construction and building material such as fine and coarse aggregates, cement, reinforcement, construction chemicals, supplementary cementitious materials and construction water to ascertain their suitability for use and the concrete mix designs conducted from reputed institutes such as NCB-Ballabhgarh, CSMRS-Delhi, IIT's, etc. as agreed by the engineer. The test samples for such full scale testing shall be jointly sampled and sealed by the engineer and contractor, thereafter these shall be sent to the concerned laboratory through the covering letter signed by field quality assurance (FQA) representative of the engineer.

4.04.00 The contractor shall timely initiate the action with regard to the evaluation of aggregates and other building material including concrete mix design, so as to ensure completion of these tests before start of civil works at site, thereby not affecting any project work. The test reports and recommendations for suitability of the materials including concrete mix design shall be promptly submitted by the contractor to the engineer.

4.05.00 Evaluation of aggregate for potential alkali-aggregate reactivity shall be carried out as per following scope of work

A. Evaluation of Aggregates for Mechanical / Physical Properties

a) To carry out different tests on coarse aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material; soundness, crushing value, impact value, abrasion value, elongation index and fiakiness index, as per IS: 2386.

b) To carry out different tests on fine aggregate sample i.e. specific gravity, water absorption, sieve analysis, deleterious material, soundness, silt content, clay content and organic impurities as per IS: 2386.

c) To prepare evaluation report based on test results of a) and b) above and to advise regarding suitability of fine and coarse aggregates.

B. Evaluation of Aggregates for Potential Alkali-Aggregate Reactivity:

a) To carry out petrographic analysis and accelerated Mortar bar Test on aggregate samples (1N NaOH at 80 deg. Centigrade for 14 days as per ASTM 1260, or the method established/ developed by CSMRS for 22days test).

b) To prepare a report based on test results of a) above and to advise regarding suitability of aggregates to be used and further testing required if any.

5.00.00 LABORATORY AND FIELD TESTING

5.01.00 The field laboratory for QA and QC activities shall be constructed and set-up by the contractor in line with the indicative field QA&QC laboratory set-up enclosed at Annexure-II. The Laboratory building shall be constructed and installed with the adequate facilities to meet the requirement of envisaged test setup. Temperature and humidity controls shall be available wherever necessary during testing of samples. The quality plan shall identify the testing equipments/ instrument, which the contractor shall deploy and equip the field quality laboratory for meeting the field quality plan requirements. The contractor shall furnish a comprehensive list of testing equipments/ instrument required to meet the planned/scheduled tests for the execution of works for OWNER acceptance/ approval. The contractor shall mobilize the requisite laboratory equipment and QA&QC manpower at least 15 days prior to the planned test activity as per the schedule of tests.

5.02.00 All equipments and instruments in the field shall be calibrated before the commencement of tests and then at regular intervals, as per the manufacturer's recommendation and as directed by the OWNER. The calibration certificates shall specify the fitness of the equipments and instruments within the limit of tolerance for use. Contractor shall arrange for calibration of equipments and instruments by an NABL / NPL accredited agency and the calibration report shall be submitted to OWNER.

5.03.00 The tests which cannot be carried out in the field laboratory shall be done at a laboratory of repute. This includes all IITs, NCB, CSMRS, reputed government / autonomous laboratories / organizations, NITs and other reputed testing laboratories. The test samples for such test shall be jointly selected and sealed by the engineer and thereafter these shall be sent to the concerned laboratory through the covering letter signed by OWNER engineer. The test report along with the recommendations shall be obtained from the laboratories without delay and submitted to OWNER.

5.04.00 Based on the schedule of work agreed with the engineer-in-charge and the approved FQP, the contractor shall prepare a schedule of tests and submit them to the engineer-in-charge and organize to carry out the tests as scheduled /agreed.

6.00.00 PURCHASE AND SERVICE

6.01.00 The major items/ equipments/ components to be manufactured in the shop of the contractor i.e. in-house items and those procured from sub-vendors / sub-manufacturer / sub-contractors i.e. bought out items (BOIs) shall be listed out by the contractor in their bid proposal.

6.02.00 An indicative list of major bought out items (not exhaustive) and services for civil works is enclosed at Annexure- III, for which the contractor shall submit the requisite details / lists of manufacturer's in their bid proposal. The list of manufacturers/ sub-vendors for all the BOIs envisaged in contract shall be included in the bid proposal by the contractor which shall be discussed / reviewed by the OWNER during post bid discussions and the list of proposed manufacturers / sub-vendors for each of the BOIs shall be agreed/ approved. If any item is left out or gets included during detailed engineering, the contractor shall propose the manufacturer's / sub-vendor's details for review / approval of OWNER, prior to initiating the procurement of such materials.

6.03.00 Where the manufacturers are placed in details required ("DR") category, the details of the manufacturers / sub-vendors placed in the "DR" category shall be submitted to the OWNER for approval in the prescribed OWNER format within the period agreed at the time of post bid discussions. The contractor's proposal shall include vendor's site facilities, expertise, facilities established at the respective works, the process capability, process stabilization, QC systems followed, experience list, etc. along with his own technical evaluation for identified sub-Contractors proposed. The formats for furnishing above details shall be given to the Contractor at post bid discussion stage. Monthly progress reports on sub-contractor detail submission / approval shall be furnished. Such manufacturers / sub-vendors approval shall not relieve the contractor from any obligation, duty or responsibility under the contract.

6.04.00 To facilitate advance planning of material testing/ approval of bought out items, well before the start of activity as per L-2 network, representative samples shall be procured by the contractor from approved sub-vendors and submitted to the engineer for his approval before bulk procurement at least two months prior to start of works. In case of manufacturers test certificate (MTC) is submitted for acceptance, it shall be clearly traceable and correlated with the consignment received at site. MTC of all bought out items shall essentially contain all the test parameters / characteristics specified in the Technical specifications / standards / codes. In case the manufacturer’s test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to OWNER. Approval of material / sample by the engineer shall not relieve the contractor of his responsibility, for their conformance to the specification, as well as the requisite performance and quality of material.

6.05.00 Structural steel supply is in the scope of the EPC contractor and shall be procured from approved vendors of APGENCO only as shown in the ANNEXURE-V. In case of non-availability of some of the sections with the approved vendors, the contractor may propose to procure the sections from the re-rollers of the main steel producers, the name of such re-rollers will have to be cleared by corporate quality assurance of OWNER for which details such as BIS approval, main steel producer's approval, past experience for production of sections of specified material, details of machines plants testing facilities etc., Confirmation that the process control and manufacturing of steel sections by re-rollers shall be same as that of main steel producers,

that billets for re-rolling will be sourced from main steel producers only shall be furnished with regards to re-roller.

6.06.00 Even after clearance of re-rollers, induction of billets with identified and correlated Mill test certificates (TC's) in the process of re-rolling, sampling of steel, quality checks thereof and stamping of final product for further identification and correlation with TC's prior to dispatch shall be the responsibility of the contractor and these shall be performed in presence of the authorized representative of the main Contractor.

6.07.00 Reinforcement steel supply is in the scope of the contractor and shall be procured from approved vendors of APGENCO. In case any size /diameter specified is not available with main steel producers and are proposed to be supplied from the conversion agent of the main steel producer the name of such conversion agent / re-roller shall have to be approved by OWNER for which details such as BIS approval, Main steel producer's approval, Past experience for production of sections of specified material, details of machines, plants testing facilities etc., and confirmation that the process control and manufacturing of steel sections by re-rollers is the same as that of main steel producers, that billets for re-rolling are sourced from main steel producers only shall be furnished with regards to re-roller.

7.00.00 MANUFACTURING QUALITY PLAN AND FIELD QUALITY PLAN

7.01.00 All materials / components and equipment covered under the scope of work, shall be procured by the contractor for the purpose of the contract, after obtaining the written approval of the OWNER, which are to be manufactured at shop/ factory of the vendor/sub vendor shall be covered under a comprehensive quality assurance programme. The contractor's purchase specifications and inquiries shall call for Manufacturing Quality Plans (MQP) to be submitted by the sub-contractor/ sub-supplier/ sub-vendor. The MQP called for from the sub-contractor shall detail out for all the components and equipment, various tests / inspection, to be carried out as per the requirements of this specification and standards mentioned therein, quality practices and procedures followed by contractor's / sub-contractor's / sub-supplier's quality control organization, the relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing. Such quality plans of the vendors / sub-vendors shall be submitted to the OWNER for approval for MQP and such approved quality plans shall form a part of the purchase order / contract between the contractor and sub-contractor. The quality plans shall be submitted on electronic form e.g. CD or E-mail in addition to hard copy, for review and approval of OWNER. After approval the same shall be submitted in compiled form on CD in addition to hard copy.

7.02.00 The contractor shall furnish copies of the reference documents/ plant standards / acceptance norms/ tests and inspection procedure etc., as referred in quality plans. These quality plans and reference

documents/standards etc. will be subject to OWNER approval without which manufacturer shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, OWNER shall identify customer hold points (CHP), i.e. test/ checks which shall be carried out in presence of the OWNER engineer or his authorized representative and beyond which the work shall not proceed without consent of OWNER in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and referred to OWNER along with technical justification for approval and dispositioning.

7.03.00 Within three weeks of the release of the purchase orders /contracts for such bought out items /components, a copy of the same without price details but together with the detailed purchase specifications, quality plans and delivery conditions shall be furnished to the OWNER for reference / record by the contractor along with a report of the purchase orders placed so far for the contract.

7.04.00 Well before the start of the work, the contractor shall prepare and submit the Field Quality Plans (FQP) and obtain approval of OWNER, which shall detail out for all the works, equipments, services, quality practices and procedures etc in line with the requirement of the technical specifications to be followed by the contractor at site. This FQP shall cover for all the items / activities covered in the contract / schedule of items required, right from material procurement to completion of the work at site. An Indicative Field Quality Plan for civil works is enclosed at Annexure - IV-A (Indicative FQP for civil works) & Annexure - IV-B (Indicative FQP for structural steel works).

8.00.00 DISPOSITIONING OF NON CONFORMITIES

8.01.00 The non-conformity for the site works on being detected / noted shall be reported by the contractor in the standard format of OWNER under the system of dispositioning of non conformity report (NCR) to the engineer. The dispositioning of the NCR relating to equipment, assemblies, materials condition or process during construction / erection shall describe the proposed correction and also include the preventive / corrective action plan for future.

9.00.00 QUALITY AUDIT

9.01.00 OWNER reserves the right to carry out quality audit and quality surveillance of the quality management and control activities, systems and procedures of the contractor or their sub-contractor. The contractor shall provide all necessary assistance to enable the OWNER carry out such audit and surveillance. The contractor shall also take necessary measures, raise NCRs wherever required based on the audit findings / observations.

10.00.00 **QA DOCUMENTATION PACKAGE**

10.01.00 The contractor shall be required to submit the QA documentation in two hard copies and two CD ROMs, as identified in respective quality plan with tick (√) mark. Typical contents of QA documentation pertaining to field activities as per approved MQP, FQP and other agreed manuals / procedures, prior to commissioning of individual system shall generally contain the Quality Plan, Material mill test reports, Non-destructive examination results / reports, Heat Treatment Certificate/Record, Non-conformance Reports, CHP, Certificate of Conformance (COC)and MDCC.

11.00.00 **GENERAL QA REQUIREMENTS**

11.01.00 The contractor shall ensure that the works, BOIs and services under the scope of contract whether manufactured or performed within contractor's works or at his subcontractor's premises or at the OWNER'S site or at any other place of work are in accordance with the OWNER technical specification, applicable standards / codes, approved drawings / data sheets / quality plans and BOQ. All the works, BOIs and services shall be carried out as per the best prevalent engineering practices and to the directions of the Engineer.

11.01.01 **Storage and Handling of Construction Materials**

All materials shall be stacked and stored by the Contractor as per IS-4082 and as per the requirements specified in OWNER Technical Specification.

11.01.02 **Excavation and Filling Works**

The contractor shall submit a work methodology covering various items of works for alt stages of excavation and filling works. This methodology shall broadly include the quantity wise and classification wise identification of source of excavation and filling, suitability tests as per specification requirements, method of stockpiling, transportation, placement, spreading , compaction, equipment, list of protocols, in-situ tests, third party lab test if required, acceptance checks for final clearance.

For blasting work at site if required, the contractor shall associate themselves with the reputed specialized blasting agency such as CMRI, NIRM for trials blasts, design blasts, blasting pattern, monitoring of blast during the blasting operations at site. The contractor shall install and operate equipment {such as tri-axial seismograph) for continuous monitoring and control of blast induced vibrations, noise level/ air pressure, dust, silica and noxious gases during all blasting operations in line with the technical specification requirements in association with the specialized blasting agency. The contractor shall submit the un-priced copy of the award on the specialized blasting agencies to OWNER, highlighting the scope of services / work awarded to them by contractor. The services of such specialized blasting agency shall be available through out the period in which the blasting work is undertaken at

site. The blasting operation shall remain in charge of a responsible, competent, authorized and experienced supervisor (man-in-charge) and thoroughly acquainted workmen, All blasting work shall be done as per approved blasting scheme/ design/ pattern in line with the technical specification requirements and all statutory laws, rules, regulations, relevant standards pertaining to the acquisition, transport, storage, handling along with use of explosives shall be strictly followed by the contractor.

Tolerance for finished surface level shall be within 20 mm of the level shown in the drawing. For an unimportant area, tolerance up to +75mm shall be acceptable at the discretion of the engineer. However, these tolerances shall be applicable for localized areas only.

Acceptance criteria shall be

a) When only one set of sample is tested, then all individual samples collected an tested should pass without any deviation

b) For retest of any sample two additional samples shall be collected and tested, and both should pass without any deviation.

c) Where a large number of samples are tested for a particular test then 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

11.01.03 **Masonry and Allied Works**

The execution, finishing, testing and acceptance of masonry related works shall be as per the provisions of technical specifications / relevant practices IS code. Local depressions on account of faulty workmanship, broken / chipped edges shall not be acceptable.

All masonry shall be built true and plumb within the tolerances prescribed as below, Care shall be taken to keep the perpends properly aligned. Unless specified otherwise the tolerances in construction of masonry works shall be as below: :

Sl. No.	Type of Check	Tolerance
	Deviation in verticality in total height of any wall of a building	Shall not exceed ± 12.5mm (more than one storey) + 6mm per 3m height (within a storey)
	Deviation from the position shown on the plan of any brickwork	Shall not exceed 12.5mm (more than one storey)
	Relative displacement between load bearing walls in adjacent storeys intended to be in vertical alignment	Shall not exceed 6mm

Sl. No.	Type of Check	Tolerance
	Deviation of bed joint from horizontal in any length, and it	Shall not exceed 6mm (upto 12m) Shall not exceed 12.5mm total (in any length over 12m)
	Deviation from the specified thickness of bed-joints, cross-joints or perpends	Shall not exceed ± 3mm
	Finished plastered surface	Deviation not more than 4 mm when checked with a straight edge of 2 m length placed against the surface
	The average thickness of plaster	Not be less than the specified thickness
	The minimum thickness over any portion of the surface	Not less than the specified thickness by more than 3 mm for plaster thickness above 12mm and 1 mm for ceiling plaster

11.01.04 **Concrete Works**

For concreting works provisions of technical specifications and IS: 456 shall apply. A detailed methodology for concrete works shall be submitted by the contractor to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for concrete works shall broadly contain the suitability of source of aggregates, cement, admixture, water and reinforcement steel, etc. The available concrete mix design recommended from a specialist institute, results of trial mix carried out at site, method / control of batching, mixing, transportation, layer wise placement, compaction, fixing / removal of form work, staging, fixing of water stops at appropriate locations along with specials, expansion joints, contraction joints and construction joints, cover blocks and method of curing, methodology of repair of newly placed hardened concrete, testing and sampling of concrete during production and placement and acceptance checks for final clearance.

The equipment, deployment of manpower and machinery shall be arranged by the contractor to ensure the continuous rate of placement of specified grade of concrete so as to prevent segregation, bleeding, formation of cold joints, temperature control for concreting in extreme weather conditions and for mass concreting works,

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition for at least seven days from the date of placing concrete in case of ordinary Portland cement, not be less than 10 days for concrete exposed to dry and hot weather conditions, at least 10 days or period may be extended to 14 days where mineral admixtures or blended cements are used. Approved curing compounds may be used in lieu of moist curing with the permission of engineer-in-charge.

Reinforcement steel shall conform to relevant IS codes. Lapping / spacing of reinforcement shall be so staggered that under no circumstances more than 50% of bars at any cross section shall be lapped. Corrosion resistance Steel shall be used for the foundations wherever specified in the technical specification. Sample test for 3% of the number of mechanical bars grips subject to a minimum of three, shall be carried out up to the yield strength of reinforcement of bars.

Test shall be conducted for the water tightness of the liquid retaining structures as per technical specifications, IS 3370 and IS 6494.

All the materials, equipments, processes used in pre cast concrete work shall conform to the requirements for the cast-in-situ concrete.

If fly ash is used in concrete, source of supply shall be checked for suitability as per IS 3812 (Part-I). Routine tests for retention of particles on 45µ sieve and loss on ignition shall be carried out on each lot of fly ash before its use. The storage of fly ash shall be similar to that of cement. Separate Silo for fly ash shall be provided in the batching plant. Validation of Mix design using fly ash shall be carried out by an approved specialist agency, before start of concrete production.

The acceptance criteria of concrete shall be in accordance with clause no,16 of IS 456. However in exceptional circumstances and that too in non-critical areas, the engineer may accept concrete work which is marginally unacceptable as per the criteria laid down in IS 456. For such accepted work, payment shall be made at a reduced rate pro rata to the concrete cube strength obtained, against that stipulated.

All records of concreting, reinforcement, testing of materials, as-built dimensions, the details of the rectification, etc, shall be maintained as given below. Four copies of such record in a bound form shall be submitted to owner for their record and future reference.

a) Testing data/report of aggregates including petrographic examination & potential reactivity of aggregate and repeated temperature cycle tests wherever specified.

b) Mix design details and record of trial mixes carried out at site

c) Testing records of admixture as per IS-9103 / ASTM C494 including third party test reports.

d) Approved scheme for concreting

e) Hourly records of concreting including pour card

f) Protocol indicating the dimensional tolerance and details of inserts

g) Records giving the details of rectification giving the location of grouting, the quantity of grout used at each location, type of grout used

h) Bar bending schedule.

i) Location and details of mechanical anchoring used for reinforcement.

j) Protocol giving the details of checking of reinforcements before concreting and conformance to the reinforcement details as shown in the construction drawings

k) Photographs showing the areas where rectification works have been carried out. Photographs should be taken before and after rectification

l) Temperature control record of concrete at the time of placement if applicable.

m) Details of curing, staging and fixing / removal of formwork, checklist for formwork as per Clause 9.9 and Annexure-C of IS 14687 including all machine foundations.

n) Batching Plant shall be calibrated regularly at least once in a 3 months Computerized output shall be taken for each batch of production of concrete. For concreting works of ash pipe pedestals, mixer with weight batcher may be used. Production and supply of concrete from batching plant shall conform to the provisions of IS 4926.

o) Dimensions (length, cross sectional dimensions, straightness, squareness, and flatness) and tolerances for pre cast members as per OWNER Technical Specification. Load test on Pre cast members (except pre- cast tiles to be laid in the reservoir) shall be carried out @ 2% up to 1000 nos., @1% from more than 1000 nos. precast members of one type. The load test shall be carried out as per the provisions of IS-456

TOLERANCES			
Description of Item/ Structural Element		**Max (mm)**	**Min (mm)**
Cast In Situ Concrete			
1.	Faces of concrete in foundations and structural members against which back fill is placed	+25	-10
2.	Eccentricity of footing as percentage of footing width in the direction of placement	2% but limited to 50mm	
3.	Top surfaces of slabs and of concrete to receive base plates to be grouted	+5	-5
4.	Alignment of beams, lintels, columns, walls, slabs and similar structural elements	+5	-5
5.	Cross sectional dimensions of walls, slabs and similar structural elements	+5	-5

TOLERANCES				
Description of Item/ Structural Element			**Max (mm)**	**Min (mm)**
6.	Deviation from specified dimensions of cross-section of columns and beams		+12	-6
7.	Alignment of holding down bolts without sleeves		+1.5	-1.5
8.	Alignment of holding down bolts with sleeves		+5	-5
9.	Level of holding down bolt assemblies		+10	-10
10.	Embedded Parts (in any direction).		+5	-5
11.	Level of embedment for equipment support		+1.5	0
12.	Level of embedment for other embedded parts		+5	-5
13.	Centers of pockets or holes with greatest lateral dimension not exceeding 150mm		+10	-10
14.	Variation in steps • Riser • Tread		 +1.5 +3.0	 -1.5 -3.0
Pre- Cast Concrete				
15.	Length:	+/-0.1 percent	+/-5	+ 10
16.	Straightness or Bow	1/750 of the length	+/-5	+/-10
17.	Cross-sectional dimensions	+/- 3 mm or +/- 0.1 percent whichever is greater		
18.	Squareness:	When considering the squareness of the corner the length of the two adjacent sides being checked shall be taken as the base line. The shorter side shall not vary in length from the perpendicular by more than 5 mm.		
19.	Flatness :	The maximum deviation from a 1.5m straight edge placed in any position on a nominal plant surface shall not exceed 5 mm.		

Placing of reinforcement and for cover	Clause 12.3.1 and 12.3.2 of IS 456
Formwork	Clause 9.6 of IS 14687 and 11.1 of IS 456
Batching	Clause 10.2.2 of IS 456

11.01.05 **Structural Steel Work**

For structural steel works provisions of technical specifications and IS: 800 shall apply. A detailed methodology for structural steel works shall be submitted by the contractor to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The contractor shall submit the welding procedures specification (WPS), heat treatment procedures, NDT procedures etc. at least ninety days before scheduled start of erection work at site. All welding and brazing shall be submitted to the OWNER and carried out as per procedure drawn and qualified in accordance with requirements of ASME Section IX/BS-4870 or other International equivalent standard acceptable to the OWNER.

All brazers, welders and welding operators employed on any part of the contract either in the contractor's / sub-contractor's works or at site or elsewhere shall be qualified as per AWSD1.1/ASME Section-IX or BS-4871 or other equivalent International Standards acceptable to the OWNER.

The records of welding procedure qualification and welder qualification test results shall be furnished to the OWNER for approval. However, where required by the OWNER, the tests shall be conducted in presence of OWNER / authorized representative.

No welding shall be carried out on cast iron components for repair. All the heat treatment results shall be recorded on time temperature charts and verified with recommended regimes.

All Non-destructive examination shall be performed in accordance with written procedures as per International Standards and as mentioned elsewhere in the technical specification. The NDT operator shall be qualified as per SNT-TC-IA (of the American Society of non-destructive examination). NDT shall be recorded in a report, which includes details of methods and equipment used, result/evaluation, job data and identification of personnel employed and details of co-relation of the test report with the job. The records of RT (Films) and UT (inspection records or printed reports if possible) shall be documented and produced to OWNER.

Low hydrogen electrode (AWS E-7018) for welding of High/Medium tensile steel, for M.S (IS 2062 Gr. A/Gr. B, IS 8500) sections thickness above 20mm shall be used. Preheating and Post weld heat treatment requirements shall be complied as specified in the technical specification / approved WPS.

The requirements of pre-heating shall be

Thickness of thickest part at the area of welding/heat affected zone	Welding using other than low hydrogen welding electrodes IS-2062	Welding using tow hydrogen welding electrodes or submerged arc welding IS 2062
Upto 20 mm (including)	None	None
Over 20 mm to 40 mm (including)	Not allowed	$20^{U}C$
Over 40 mm to 63 mm (including)	Not allowed	$66^{U}C$
Over 63 mm	Not allowed	$110^{U}C$

The following tests / checks shall be carried out for structural steel works

Sl. No.	**Tests / Checks**	**Quantum / Standard**
1.	Physical and chemical properties of material if supply in the scope of contractor	As per relevant codes, review of correlated mill test certificates or check testing in absence of MTC
2.	Ultrasonic test on plates above 40mm	As per ASTM A435
3.	Welding procedure & welders qualification test	AWSD1.1/ASME Section-IX or BS-4871 or other equivalent International Standards
Fillet Weld		
4.	Macro-etch examination on production test coupons for main fillet welds	Minimum one joint per built up beams, columns and crane girder etc.
5.	tension member of crane girder	Dye penetration test on 25% weld length
6.	All other fillet welds	DPT on 25% of the total length. Dye penetration test shall be carried out to the root run.

Sl. No.	Tests/Checks	Quantum/Standard
Butt Weld		
7.	DPT	100% after back gouging on ail butt welds except for coal bunker bins 10% after back gouging-For coal bunker bins 100% of the total length. Dye penetration test shall be carried out to the root run after back gouzing.
8.	Mechanical testing of production test coupons	Minimum one joint per built up beam, column and crane girder.
9.	Radiography test on butt welds (In case of failure of any welds in SPOT/RT or UT the % of retesting shall be doubled at that particular location. Acceptance criteria of NDT on welds shall be as per AWS D1.1. Wherever RT is not feasible UT to be carried out with the approval of the engineer)	100% RT on butt welds of tension flange (bottom flange) of crane girders 10% RT weld length of each welder on butt welds, except for crane girders and coal bunker 5% spot RT on butt welds / at inaccessible locations UT on butt welds- For coal bunker bins 100% radiography test shall be carried out for the plates of 32mm thick and above. 25% radiography test shall be carried out for the plates below 32mm thick. 100% radiography test shall be carried out of the crane girders and bunker girders irrespective of thickness of the plate.
10.	Ultrasonic testing on full penetration welds (other than butt welds)	100% UT on the web to flange joint of crane girder 10% UT on other full penetration joints
11.	Control assembly check in shop before erection	1st and further every 10th set of identical structure

Sl. No.	Tests /Checks	Quantum / Standard
12.	Dimensional tolerances during fabrication and erection	as per IS-7215 and IS-12843
13.	Surface Preparation and Paint thickness	SA 2.1/2 , By elcometer random after each coat, each member
CW Liners site fabrication (Field shop) test		
14.	WPS.PQR& welder's Qualification	100%
15.	DPT on root run	100% DPT for pipes upto 1200mm diameter
16.	DPT after back gouging	100% DPT for pipes above 1200mm diameter
17.	UT	Not recommended.
18.	RT	5% RT
19.	DPT on finished butt welds	10% DPT
20.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure which ever is higher.
CW Liners erection site test		
21.	WPS.PQR& welder's Qualification	100%
22.	DPT on root run	100% DPT for pipes upto 1200mm diameter
23.	DPT after back gouging	100% DPT for pipes above 1200mm diameter
24.	UT	Not recommended.
25.	RT	5% RT
26.	DPT on finished butt welds	10% DPT
27.	Hydraulic tests	1.5 times the design pressure or 2 times the working pressure which ever is higher. In cases where hydraulic test is not possible the same may be substituted with 100%RT
28.	Tolerances	As per approved drawings, as per IS : 7215 for fabrication and IS : 12843 for erection of steel structures

11.01.05.1 **Stoplog and Trash Racks**

Structural design shall be as per IS 5620 and IS 4622 and as per details given in technical specifications. The trash rack to be provided shall be Type-1 trash rack (removable section rack), conforming to IS: 11388 (latest). Filling valves shall be provided in the stop logs to balance the water pressure before lifting the stop log. Leakage test shall be carried out in the stop logs as per the methodology specified in the technical specification. The leakage measured shall not be more than 5 liters/ minute /meter of length of seal under maximum head. Radiographic examination or magnetic particle testing or other comparable tests shall be carried out for determining the soundness of steel castings and shall be conducted by the contractor as per the technical specification requirements. The contractor shall submit a manufacturing and field quality plans in OWNER format incorporating all the quality aspects mentioned in the technical specifications.

The lifting beam is to be tested for twice the weight of the heaviest component to be lifted by the beam. IS 13591 shall be referred for measurement of the deflection and acceptance criteria.

11.01.05.2 **Coal Tar Anti-Corrosion Tape**

Coal tar anti corrosion tape shall conform to the requirements of technical specifications. The Manufacturers test certificate for each lot of supply of the coal tar anti corrosion tape shall contain the softening point, needle penetration, filler content, breaking load in the longitudinal direction, service temperature, direct impact test, cathodic disbanding and solubility, in case the manufacturer's test certificate does not mention these details, sample from each lot shall be tested for these properties at the third party lab acceptable to OWNER.

Tests for Adhesion**,** holiday test and thickness shall be carried out at site**.**

11.01.06 **Painting Works**

Painting works shall be carried out as per the provisions of technical specifications. A detailed methodology for painting works shall be submitted by the contractor to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for painting works shall broadly contain the source of approved brand of paints, shot / sand blasting as specified, minimum acceptable size of shot used for blasting, application of primer, intermediate coat and final coat, experience of applicator, etc. testing of painting work and acceptance checks for final clearance. For PU coating works if specified, material shall be procured from OWNER approved source and the application of the PU coating shall be carried out by an experienced authorized applicator of the material supplier approved by OWNER. A separate quality plan and methodology for PU coating works shall be submitted by the contractor for

approval of OWNER. Based on the approved quality plan, the tests on material and works shall be got conducted at specialist laboratories like IICT Hyderabad, CECRI Karaikudi.

11.01.07 **Sheeting Works**

All bought out items shall be procured from the manufacturer's approved by engineer and tested as per relevant IS Codes/ Specification. Raw material of colour coated sheets shall meet the chemical & physical properties as per relevant standards / codes referred in the approved data sheet. It shall be tested for colour match, bare metal thickness, weight of Z/AZ coating, thickness of painting system, reverse impact, T-Bend adhesion, scratch resistance, salt spray test for 1000 Hrs. and any other test / properties as specified in the technical specifications. Colour coated sheets shall be marked with video jet printing at the interval not more than 2m bearing manufacturer's name, date and time of manufacturing. Fasteners shall also be tested for 1000 hrs salt spray test as per the requirement of technical specifications.

Bonded Mineral Wool Insulation shall meet the requirements of thickness, density, thermal Conductivity, all other tests as per the technical specifications and IS-8183.

For sheet installation no gas cut opening shall be allowed at the site, whenever opening is specified these shall be properly cut in the factory and shall be filled with lipping / flashing for true shape / dimension etc. The sheets/ packets shall be stacked neatly clear off the ground at an angle to the ground, over a base pallet to provide drainage. Water / moisture should not be allowed to stagnate on surface, or in between layers. This can damage the coating, and cause corrosion.

11.01.08 **Tile Works**

The execution, finishing, testing and acceptance of tile works shall be as per the provisions of technical specifications. The material for tile works shall be procured from the OWNER approved brand / source**.** Local depressions on account of faulty workmanship, tiles / natural stones with cracked or broken / chipped edges shall not be acceptable.

The tests shall be carried out on acid resistant bricks / tile- water absorption, compressive strength, resistance to acid, flexural strength, dimensions and all other tests as per IS 4860 and IS 4457, bitumastic ready mixed paint as per IS 158, bitumastic as per IS 9510, potassium silicate, resin type and sulphur type mortars as per IS 4832, part I, II and III, surface preparation for painting as per IS 2395, epoxy painting shall be carried for required coating thickness and dry film thickness.

11.01.09 **Fire Proof Doors**

Fire Proof doors shall be tested for the requirements mentioned in the Technical Specification. The type test of the doors shall be carried out at CBRI Roorkee for minimum 2 hours fire rating and its Fabrication drawing shall also be approved by CBRI, Roorkee. DFT of paint of Fire Proof Doors and its fittings and fixtures as per BOQ shall be checked. The doors shall be finished with suitable fire retardant painting system

11.01.10 **Water Proofing**

The execution, finishing, testing and acceptance of water proofing works shall be as per the provisions of technical specifications. The material for the works shall be procured from the OWNER approved brand / source and the works shall be executed by the authorized applicator of the supplier.

Water proofing shall be tested for water tightness by creating a pond of water minimum 25 mm height on area of 6 m x 6 m, for the period of 48 hrs on fully dried elastomeric membrane surfaces. Minimum 5% area of the roof shall be subjected to water tightness test. Such test necessarily be conducted on vulnerable areas like drain channel / drain head. No dampness shall be visible on the underneath side of roof (i.e. ceiling), parapet and wall junctions etc. which have been subjected for testing. The above testing shall be earned out prior to application of wearing course.

11.01.11 **Piling Work**

For piling works provisions of technical specifications, approved drawings, BOQs and relevant IS codes / standards shall apply. The piling works shall be executed by the agency meeting the qualifying requirements as specified. A detailed methodology for piling works shall be submitted by the contractor to OWNER for approval. The methodology may require change / modification based on the site conditions, for which suitable revisions shall be submitted.

The methodology for piling works shall broadly contain the method of boring, stability of bore hole, termination criteria, tests / checks for termination level, fabrication of cage, cage lowering, concrete batching / mixing, transportation, placing, recording of the time of construction operations, method of conducting initial and routine load tests, testing and sampling of concrete during production and placement and acceptance checks on piles for final clearance.

The equipment, deployment of manpower and machinery shall be arrangement by the contractor to prevent the collapse of bore hole and to ensure continuous rate of placement of specified grade of concrete.

The piling works shall be executed as per the technical specifications, approved drawings, relevant codes / standards, FQP and BOQ. In addition to the requirements of technical specifications, the following shall also be ensured while execution of piling works :

a) Time gap between completion of pile boring and start of concreting should be kept to the minimum. However the maximum time gap shall not be more than 6 hours.

b) Muck Debris should be removed from the pile bore by air lift technique(by keeping the tremie & air pipe as close as to bottom of pile bore) i.e. after completion of boring, after completion of SPT(wherever applicable), after lowering reinforcement cage, but before start of concreting.

c) Density of bentonite slurry shall be checked from the sample taken from the bottom of pile bore (not at 1.0 m above the bottom of the pile bore)

d) Minimum two welding sets shall be kept ready to join the two cages of reinforcement by engaging 3 or more welders. This will ensure the lowering of R/F cage in minimum time.

e) While lowering the R/F cage into the pile bore, two hooks shall always be used to ensure balanced/symmetrical insertion of cage into the pile bore.

f) Concrete cover blocks at the junction of two R/F cage shall be ensured before lowering the second segment.

g) Surge concreting of about 1.0 cum shall be ensured at the start of concreting (i.e. in the first pour), by suddenly allowing to fall through the tremie pipe from the funnel. This will help in displacing left out muck/debris in the pile bore (by the impact).

h) Continuous feeding of concrete shall be ensured by deploying at least two transit concrete mixers (if required to be deployed) and mixing done through concrete batching plant (if deployed). Cold joints in the pile shall be avoided.

i) In a pile group, SPT shall be carried out at termination level in the pile, taken up first.

j) Bentonite slurry circulation to be ensured from start of boring to start of concreting. Flushing of bentonite slurry will only ensure maintaining of density of bentonite slurry uniformly and will not allow bentonite jelly to settle at the bottom, whereas air lift technique with bentonite circulation will ensure removal of muck debris from the bottom of pile bore.

k) Properties of drilling mud shall be checked prior to commencement of the piling work and thereafter, minimum once per week or as found necessary by the engineer. One sample consisting of 3 specimens shall be tested for the above.

l) Low strain pile integrity test on all job piles and test piles shall be conducted as specified in the Technical Specification. This test shall be suitably used to identify the piles for routine tests. High Strain dynamic test shall be done as per the technical specification. The frequency of the test shall be as per the BOQ

m) For Working Piles: Minimum one sample consisting of 6 test cubes shall be made for first ten piles. Out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength. Minimum one sample of 6 test cubes for every 25 nos. of piles shall be tested, out of these 3 shall be tested for 7 days cube strength and 3 for 28 days cube strength

Pile Load Test

Pile load testing shall conform to the requirements of IS-2911 (Part IV) and the technical specification. Initial load tests as specified in the contract documents shall be conducted to assess the safe load carrying capacity of pile before start of work. To verify the load carrying capacity of the working piles, routine load test shall be conducted.

Pile load-testing procedure and the test setup / scheme shall be submitted for approval of OWNER. The contractor shall use the test setup having arrangement for anchor piles / rock anchors alone or combination of anchor piles / rock anchors and kentledge for both vertical compression and uplift (tension) Load test (initial) on piles. The cost of reaction system / piles shall deem *to* be included in the cost of test piles

All the gauges and instruments shall be calibrated before the start of the tests on test piles and working piles and the calibration record shall be verified before start of execution of the test.

11.01.12 **Water Supply, Drainage & Sanitation**

Material used for sanitary and plumbing fittings and fixtures shall conform to and be tested as per the requirements of relevant IS Codes specified in OWNER technical specification.

The obstructions in sewer lines shall be checked by inserting a smooth ball, of diameter 13 mm less than the pipe bore at the high end of the sewer or drain. If absence of any obstructions, such as yarn or mortar projecting through the joints, ball shall roll down the invert of the pipe and emerge at the lower end. The straightness shall be checked by means of a mirror at one end of the line and lamp at the other. If the pipeline is straight, the full circle of the light may be observed. The mirror will also indicate obstruction in the barrel, if the pipeline is not straight.

The service pipes shall be slowly and carefully charged with water, allowing all air to escape avoiding all shock or water hammer. The service pipe shall then be inspected under test / working condition of pressure and flow, when all draw-off taps are closed. The service pipes shall be checked for satisfactory support and protection from damage, corrosion and frost.

11.01.13 **Architectural & Misc. Works**

Material used for sanitary and plumbing fittings and fixtures, floor finishes and allied work shall conform and tested as per the requirements of relevant IS Codes specified in OWNER technical specification.

Fabricated item like metal doors, windows, ventilators, louvers, rolling shutters and grills etc. shall be checked for correctness of locations and smoothness of operation and fixtures. All controls and locking devices shall give fault free performance. Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 2.5 mm.

Materials used in glass and glazing shall be procured from source approved by OWNER and shall conform to the requirements of the Technical Specification and IS Codes.

False ceiling panels shall be best quality material in thickness and properties called for in the specification / schedule of items. Material Test Certificate to be submitted before bulk supply.

All bought items covered in the scope of contract shall be procured from sources approved by OWNER and shall conform to the requirements of the technical specifications and referred standards / codes.

11.01.14 **Road Work**

Quality Assurance and testing requirements for roadwork shall be as per the MOSRTH-Specification (Section 900), IRC specifications or CPWD specifications as specified in the technical specifications and BOQ of the contract.

The testing and sampling shall include the checks on earth work for embankment and subgrade, sub bases and bases and bituminous constructions. The sampling and testing of concrete pavements shall be as per the respective items of earthwork, subgrade / sub-base, concrete, etc.

11.01.15 **Fabric Expansion Compensator**

Each layer of fabric Compensator shall be checked for thickness, unit weight, tensile strength & elongation, composite layer of the expansion joint shall be tested for temperature withstandability test.

Thermal Insulation shall be checked for thickness, density, thermal conductivity test and all other tests as per IS:8183.

Tests and checks on all other items shall be carried out as per relevant codes.

11.01.16 **QA Requirements for Slip form Shuttering**

1. The monitoring of the leveling of the yoke and the platform of the slip form shuttering to be done in each shift to avoid tilt during the casting of the chimney shell.

2. Manning of each shift shall be done by at least two experienced operators and a foreman particularly in night shift.

3. Suitable removal/ reduction of overhung / excess yoke beam length shall be affected with the decrease in the diameter of Chimney shell, as per the approved plan.

4. The laser centering method to be deployed for chimney alignment and Monitoring of chimney centre should be done by laser instruments at least two points. Monitoring/Recording of the same shall be done in each shift of 8 hours

5. Shuttering plates to be used for slip form shall be new and the grade of steel shall conform to the specification requirements.

6. The outage of the alignment of chimney centre shall be prevented by creating a counterbalance for alignment purpose to avoid differential loading, arising out of placement of reinforcement bars at one side or unloading of concrete in a hopper at one side of the platform for slip form shuttering.

11.01.17 **QA Requirements for Dyke Work/Impervious Soil Fill/ Other Fill Works**

The suitability of the fill materials from each source using laboratory/ field tests shall be determined / ascertained by the contractor prior to start of filling work and shall be approved by Engineer. The fill material free from shingle, salts, organic matters, roots sod or any other foreign substances shall be used for filling.

11.01.17.1 **Embankment Filling**

The fill materials shall be free from debris, wood, vegetable matter and other deleterious matter. Control tests shall be carried out in laboratory from time to time to determine whether the fill produced by methods employed satisfies the requirements of the specifications. Routine field tests shall also be carried out by the Engineer and the work shall be inspected regularly. Field density test should be particularly and specially made in the following areas:

a) Where the degree of compaction is doubtful.

b) Where embankment operations are concentrated i.e. where 2 or more layers are placed one over the other on the same day.

c) To represent every 2000 cum in case of earth and/or 1000 cum in case of ash placed in the embankment.

d) Atleast one test for every full or part shift of compaction operations and

e) Atleast one test for every 250 m length of dyke in each layer. The Engineer shall determine whether the desired results are being obtained.

QA&QC test for Embankment Filling shall be carried out in line with the Technical Specification, PART-B.

11.01.17.2 **Impervious Soil Filling**

The suitability of the material from each source shall be determined by laboratory tests and shall be approved by Engineer. QA&QC test for Impervious Soil Filling shall be carried out in line with the Technical Specification, PART-B. The spreading of the next layer shall be carried out only after the underlying layer has been approved by the Engineer or his authorized representative.

11.01.17.3 **Sand Blanket, Chimney And Filter**

The material for blanket, chimney and sand filters shall consist of clean sound and well graded coarse sand. The materials shall be free from debris, wood, vegetable matter and other deleterious matter. The gradation of sand material shall meet the requirements as specified. QA&QC test for Sand Blanket, Chimney and Filter shall be carried out in line with the Technical Specification, PART-B.

11.01.17.4 **Graded Coarse Aggregate Filter**

The coarse aggregate material shall consist of durable well graded broken rock of hard stone variety from the specified quarries and shall be approved prior to being transported to the area of deposition. The materials shall range in the size from 10 mm to 75 mm and shall satisfy the specified filter criteria. QA&QC test for Graded Coarse Aggregate Filter shall be carried out in line with the Technical Specification, PART-B.

11.01.17.5 **Rock-Toe, Rip-Rap Works, Rr Masonary**

Rock toe shall be formed with rock material consisting of sound, durable and well-graded broken rock obtained from approved quarries and shall be of approved quality. The materials shall range in size from 10 to 45 cm. QA&QC test for rock-toe, rip-rap works hall be carried out in line with the Technical Specification, PART-B.

11.01.17.6 **Slope Protection Works**

Slope protection works with dry brick packing or ash-cement/ soil-cement mortar ash cement concrete on the slopes, confined within brick masonry panel walls shall be constructed with approved quality of materials. Slope protection works with turfing on downstream slope shall be as per IRC standards. Slope protection works with ash cement concrete on the downstream slopes shall be constructed with approved quality of materials. QA&QC tests for slope protection works shall be carried out in line with the Technical Specification, PART-B.

11.01.17.7 **Bentonite Liner**

Construction Quality Control (CQC) tests as indicated in Table shall be performed by the Contractor's Quality Control Team at regular intervals upon completion of the Soil-Bentonite liner.

QCQ Requirements for Impervious Liner

Parameter	Test Frequency per layer
Moisture Content	1 per 5,000 Cum
Field Density	1 per 5,000 Cum
Falling Head Permeability	1 per 25,000 Cum

All CQC test results shall achieve the required values as established by the engineer. Failure to achieve these values shall require re-working of the Impervious mixture in the failed areas.

12.00.00 **SHOP TEST EOT CRANES, OTHER CRANES & HOIST**

1.0 **Hooks**

1.1 All tests including proof load test as per relevant IS/BS/DtN shall be carried out.

1.2 MPI/DPT shall be carried out after proof load test.

2.0 **Steel Casting**

2.1 DPT on machined surface shall be carried out.

3.0 Girders, end carriage.crab, gear box and rope drum

3.1 The plates of thickness 25mm and above shall be ultrasonically tested.

3.2 NDT requirements on weldments shall be as follows:

a)	BUTT WELDS IN TENSION	:	100% RT AND 100% DPT
b)	BUTT WELDS IN COMPRESSION	:	10% RT AND 100% DPT
c)	BUTT WELDS IN ROPE DRUM	:	100% RT AND 100% DPT
d)	FILLET WELDS	:	RANDOM 10% DPT

4.0 Forging (Wheel, Gears, Pinions, Axle, Hooks & Hook Trunion)

4.1 All forgings greater than or equal to 50 mm diameter or thickness shall be subjected to ultrasonic testing.

4.2 DPT/MPI shall be done after hardfacing and machining.

5.0 Wire rope shall be tested as per relevant standard.

6.0 Reduction gears shall be tested for reduction ratio, backlash & contact pattern. gear box shall be subjected to no-load run test to check for oil leakage, temperature rise, noise and vibration.

7.0 The cranes shall be completely assembled at shop for final testing. all tests for dimension, deflection, load, overload, hoisting motion, cross travel etc. as per is-3177 shall be carried out at shop.

8.0 All electric hoists shall be tested as per is-3938 and chain pulley blocks shall be tested as per is-3832.

13.00.00 **CATHODIC PROTECTION**

Quality of cathodic protection system shall be as per given table.

IMPRESSED CURRENT CATHODIC PROTECTION

Transformer Rectifier Unit

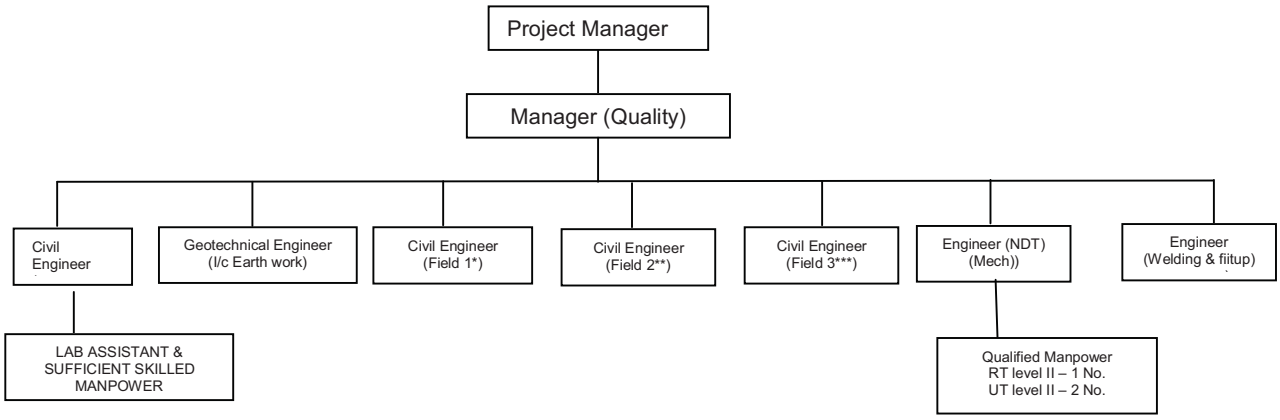
Attributes Characteristics → / Items / Components / Sub-assembly ↓	Make, Model, Type, Rating & Finish	Chemical & Mechanical Tests	Sheet Steel Pretreatment & Painting process checks	Operational & Functional Checks	Conform to relevant Standard	Dimensional check and Paint shade, thickness, adhesion & Finish checks	Complete physical examination for constructional features of TRU as per OWNER specification	Efficiency Test on TRU & Transformer	Heat Run Test	Ratio & Polarity Test on TRU	HV & IR Test
Rectifier Transformer (IS : 2026)	Y				Y			Y			Y
Electronic Components	Y				Y						
PCB & Electronic Cards	Y				Y						
Control & Selector Switches (IS : 6875)	Y			Y	Y						
Indicating Meters (IS : 1248)	Y			Y	Y						
Indicating Lamps (IS : 13947)	Y			Y	Y						
Air Break Switches / Fuses (IS : 13947/13703)	Y			Y	Y						
Control Terminal Blocks (IS : 13947)	Y				Y						
Control Transformer (IS : 12021)	Y			Y	Y						
Push Buttons (IS : 4794)	Y			Y	Y						
MCB (IS : 8828)	Y			Y	Y						
PVC insulated Copper control wires (IS : 694)	Y				Y						
Sheet Steel (IS : 513)	Y	Y	Y		Y						
Synthetic Rubber Gaskets	Y	Y			Y						
Annunciator	Y			Y							
Transformer Rectifier Unit	Y					Y	Y	Y	Y	Y	Y

Notes

1. This is an indicative list of tests / checks. The manufacturer is to furnish a detailed Quality Plan indicating the practice and procedure along with relevant supporting documents.

2. Makes of all major Bought Out Items will be subject to OWNER approval.

QA & QC ORGANISATION SETUP



NOTE :

1. The above organization setup is minimum however their deployment shall be as per the agreed deployment schedule. The contractor shall prepare a manpower deployment schedule in line with the finalized work plan and the same shall be submitted to the engineer-in charge for acceptance/ approval.

2. The contractor shall mobilize the QA& QC manpower in line with the finalized manpower deployment schedule and shall ensure their availability well in advance (15 days approx.) of the beginning of the concerned activity/ work.

3. The contractor shall further mobilize required number of skilled & supporting staff and additional resources, if any to meet the work schedule.

4. For concrete work 2 Nos. (one for foundation work & one for superstructure)

5. ** For lines and levels -1 No.

6. *** For Finishes and cladding work -1 No

TYPICAL QA/QC LAB EQUIPMENT

Sl. No.	Equipment	Nos.
1	Vicat Apparatus with deskpot	2
2	Le chatelier flask	2
3	Le chatelier Mould	2
4	Cube Moulds for cement testing	12
5	Vibration Machine	1
6	Length comparator	2
7	Shrinkaqe Bar mould	2
8	Sieve shaker	1
9	Sieves for sand, coarse & fine aqgregate	1 set for each
10	Sieves for coarse aggregate for Road	1 set
11	Proctor testing equipment '	2 sets + 18 cores
12	Slump testing equipment	6 sets
13	Oven	2
14	Physical balance	1
15	Rapid moisture meter	2
16	Thermometer	4
17	Burret	2
18	Measuring cylinders	9
19	Measuring flasks	3
20	Compression testing machine	2 sets of 2000 kN capacity each
21	Cube moulds	30
22	Electronic balance	2 (12 kg capacity), 2 (200 mg capacity)
23	pH balance	As per requirement
24	Radiographic facilities	As per requirement. Party should deploy BARC approved agency for carrying out RT
25	Mechanical weighinq machine	1 (100 kg capacity)
26	Ultrasonic testing machine	As per requirement
27	D.P. Test kit	10
28	Vernier 300 mm. 600 mm	2
29	Micrometer (0.25 mm) out side (25.00)	2
30	Radioqraphy film viewer	2
31	Inside Micrometer 25-750 dia	2
32	Digital elcometer for paint thickness	2
33	Baking oven for electrode	3
34	Portable ovens	2
35	Rebar detector to locate the reinforcement before core cuttinq operation	1
36	Concrete coring machine (55mm, 60mm upto 150 mm dia core bit)	1
37	Rebound hammer	1
38	Ultrasonic pulse velocity tester	May be arranged from specialist laboratory.

1. The equipments listed above are indicative and required to be mobilised as minimum requirement, additional equipment if any .required for successful completion of work shall be provided /arranged by the contractor.

2. All test reports/ inspection reports have to be computerized and maintained on LAN with an access to the owner

3. Computers - 2 Nos. shall be deployed with Windows operating system and connected to the OWNER server

4. Based on the schedule (L2/L3 Network), Quality control & Quality Assurance work plan shall be finalized by the contractor and the same shall be submitted to the engineer-in-charge for acceptance/approval. The Finalized work plan shall be maintained on the computer to be accessed by the owner for database and day to day monitoring.

INDICATIVE LIST OF BOUGHT OUT ITEMS FOR CIVIL WORKS

Sl. No.	Bought Out Item	Proposed Make	Proposed list of Manufacturers
1.	Cement, if procured by Contractor		
2.	Structural and Reinforcement Steel, if procured by Contractor		
3.	Construction Chemicals- admixtures, waterproofing, accelerators, Epoxy Resin, grouts etc.		
4.	Bitumen, Bitumen Impregnated Fiber Board Joint Filler, Joint Sealing Compound, Bituminous Compound, Joint Sealant		
5.	Colour Coated Sheets		
6.	Paint and Painting System, PU Coating		
7.	Floor Tiles / Flooring/ Acid & Alkali resistant tiles		
8.	Glass and Glazing		
9.	False Ceiling - Glass Reinforced Gypsum System, Mineral Fiber Board System, Pre-painted Coil Coated Steel System		
10.	PVC water stops, hydrophilic strips,		
11.	Particle Boards, Plywood, Fire proof doors		
12.	Roof Water Proofing		
13.	Electro-Forged Gratings		
14.	Anodized Aluminum Sections		
15.	Fittings and fixtures for water supply works		
16.	PVC Pipes and accessories		
17.	Polyethylene water storage tank		
18.	Heavy duty anchor fasteners		
19.	Stop log. Trash Rack, Lifting Beam etc.		
20.	PTFE Bearing		
21.	Flexible Open Bellow Strap		
22.	HDPE Liner		
23.	Cathodic protection system		
24.	Anti weed treatment		
25.	HSFG Bolts		
26.	Any other specific high value and critical bought out Item required, meeting the specification requirements		

Note : The Bidders are required to indicate the list of proposed manufacturers/ sub-vendors for each of the BOI in their Bid proposal, which shall be discussed for finaiization at post bid stage.

LOGO	SUPPLIERS NAME AND ADDRESS:	INDICATIVE FIELD QUALITY PLAN									ANNEXURE-IVA
		ITEM : CIVIL WORK SUB-SYSTEM: GEOTECH INVI, FOUNDATIONS, EXCAVATION & FILL, SITE LEVELLING, CONCRETE, ROAD, BUILDING ETC.		Q.P.NO.: REV. NO.; DATE: PAGE:		1 0 Page 18 of 18	PROJECT: PACKAGE: CONTRACT NO. MAIN CONTRACTOR				
Sl. No	Activity and operation	Characteristics / instruments		Class of check	Type of Check	Quantum Of check	Reference Document	Acceptance Norms	Format of Record	D*	Remarks
1	2	3		4	5	6	7	8	9	D*	10
14.4											
i		moisture content (for concrete and mortar only)	as required	B	Physical	Once per week	IS:2386, IS:363 and Technical Specifications		SR/TR		
ii		gradation- grain size analysis	sieve set	A	Physical	Once for each source	IS -2386 Part I. IS :9429 & IS :383 and Technical Specifications		SR/TR	√	
iii		specific gravity	pycnometer	A	Physical	Once for each source	IS:2386 part-I and Technical		SR/TR	√	min 2.40
14.5	Rock Material for Rip Rap, Rock Toe and Random Rubble Masonry										
i		Specific gravity	as required	A	Physical	Once for each source	IS:1122 and Technical Specifications		SR/TR	√	Min 2.5
ii		sulphate soundness	Chemicals, oven balance etc,	A	Physical	Once for each source	IS:1126and Technical Specifications		SR/TR	√	Maximum 10% weight loss after five cycles
iii		Impact Value	Impact Value testing appratus	A	Physical	Once for each source	IS:2386 and Technical Specifications		SR/TR	√	Max. 30%
iv		Water absorption	Balance, oven	A	Physical	Once for each source	IS:2386 and Technical Specifications		SR/TR	√	Minimum 2.5%
v		slake Durability	as required	A	Physical	Once for each source	IS:10050 and Technical Specifications		SR/TR	√	Minimum 85 % after two cycles of 10 minutes
vi		placement profile thickness	as required	B	Physical	Random in each shift	IS:8237 and Technical Specifications		SR/TR	√	
15.0	GEOTECHNICAL INVESTIGATION WORK										
i		Deployment of approved Geotechnical Investigation Agency - Equipments, Manpower etc	As required/agreed	A	Physical	Once before commencement of work	As per technical specifications and relevant IS Codes		SR	√	
ii		Execution of Geotechnical Investigation locations, type etc as per scheme	As required / agreed	B	Physical	Each Location	As per technical specifications and relevant IS Codes		SR	√	
iii		Collection of disturbed and undisturbed samples, their packing and storage	As required / agreed	B	Physical	each sampling	As per technical specifications and relevant IS Codes		SR		
iv		Conducting filed tests as per investigation scheme- such as, SPT/ERT/SCPT/PLT/PMT etc	As required / agreed	B	Physical	each field test	As per technical specifications and relevant IS Codes		SR		
V		Submission of Field Borelogs in approved format	As required / agreed	B	Review	Within 24 hours after completion of each BH	As per technical specifications and relevant IS Codes		SR	√	
vi		Submission of laboratory test schedule and selection of samples for laboratory testing	As required / agreed	A	Review and acceptance	as per consultation with Engineer during dispatch of samples to approved laboratory	As per technical specifications and relevant IS Codes		SR	√	
VII		Submission of Final Geotechnical investigation report along with recommendations	As required / agreed	B	Physical	After completion of investigation work and review of draft reports	As per technical specifications and relevant IS Codes			√	
		Legend to be used: Class #: A - Critical, B-Major, C=Minor, SR, TR, MTC, LB									

LOGO	SUPPLIERS NAME AND ADDRESS:	INDICATIVE FIELD QUALITY PLAN						ANNEXURE IVB			
		ITEM : STRUCTURAL STEEL WORK		QP NO.:			PROJECT:				
				REV. NO.:		0	PACKAGE:				
		SUB-SYSTEM: FABRICATION & ERECTION		DATE:			CONTRACT NO.				
				PAGE:		7 of 7	MAIN CONTRACTOR				
Sl. No	Activity and operation	Characteristics / instruments		Class* of check	Type of Chech	Quantum Of check	Reference Document	Acceptance Norms	Format of Record		Remarks
1	2	3		4	5	6	7	8	9	D*	10
ii		Tolerance OD / ovality	steel tape	B	Measurement	100%	As per approved drawing		SR		
13.8	HYDRO TESTING										
		Leakage tightness	Hydro test Arrangement	A	Leakage tests	100%	Tech Specificatiort		SR	√	For shop welded joints before encasement in concrete/ painting and erection joints
14.00	STOP LOG GATE, TRASH RACK AND LIFTING BEAM										
14.1	MATERIAL										
		Check Quantity (in case of receipt) and completeness and damage, surface defects		C	Visual	100%	Challan / Release No damage, surface defect note		SR	√	
14.2	ERECTION										
		Alignment levelling	Plumb, Piano wire,water level	C	Measurement	100%	Specfication/ Approved drawing		Inspection Report		Welding, if any, involved at site will be done by welders and procedure qualified as per ASME-IX in presence of OWNER's Engineer
14.3	PAINTING / SURFACE PREPARATION										
i		Shade		B	Visual	100%	Specfication/ Approved drawing		Inspection Report		The type of painting/ surface treatment of parts shall be as per Technical
ii		DFT	Elcometer	A	Measurement	Random	Specfication/ Approved drawing		-do-	√	
14.4	TESTING										
i.	Free movement of stop log / trash rack in guides under dry and under full water condition	Lowering or raising for full length for 2/3 times		A	Physical	100%	Smooth operation, Tech. Specification, iS:4622		-do-		
ii	Leakage for stop Log	Measurement of leakage	As read,	A	Physical	100%	Leakage rate within limit		-do-	√	Maximum leakage rate 5 litre/minute/metre length of seal under max-head as per IS:4622
iii	Load test for lifting beam	Load Test	As reqd.	A	Physical	100%	No deflection /No Deformation		-do-	√	
		LEGEND: D * Records, identified with Tick* (√) shall be essentially included by supplier in QA									
		Legend to be used: Class #: A= Critical, B=Major, C=Minor, SR, TR, MTC, LB									
Manufacturer/ Sub supplier	Main-supplier	Categorization Witnessing & Accepting (As per owner QA&I System) Category 'A' FQA Engineer In association with Executing Engineer, Category 'B' Executing Engineer, Category 'C' Executing Engineer ;SR - Site Register, TR= Test Report,MfrTC = Manufacturer's Test Certificate									
Signature		This document shall be read in conjunction with owner Tech. Specifications, BOQ, Drawings									

VOLUME : IIG/3

SECTION-XI

TECHNICAL SPECIFICATION
FOR
ROADS AND DRAINAGE

CONTENT

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SECTION-XI

TECHNICAL SPECIFICATION FOR ROADS AND DRAINAGE

1.00.00 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, preparation of sub-base, water bound macadam, bituminous macadam, wearing course etc. excluding toppings and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Notwithstanding the provisions of the technical specification, all road works shall be carried out as per IRC / MORT&H specification.

This specification also includes all work required for drainage including road side RCC drain, RCC culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

b) Submit for approval detailed schemes of all operations required for executing the work e.g. material handling, placement, services, approaches etc.

c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.02.00 **Work to be provided for by others**

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.03.00 **Codes and Standards**

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant I.S. Specifications and Codes of Practice.

1. Specification for road and bridge works of Ministry of Road Transport & Highways (Fourth Revision). Published by the IRC, New Delhi-2001.

2. IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.

3. IRC : SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

4. IS : 456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

5. IS : 783 Code of Practice for Laying of Concrete Pipes.

6. IRC : 36 Recommended Practice for Construction of Earthen embankments for Road Works.

7. IRC : 37 Guidelines for the design of Flexible pavements

8. Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by Indian Standard Specification, any other standard practice as may be specified by the Engineer shall be followed.

2.04.00 **Conformity with Designs**

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.05.00 **Materials to be Used**

2.05.01 **General**

All materials required for the work shall be of best commercial variety and as approved by the Engineer. Material to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in MORT&H Specification and specification for relevant items of work carried under these specifications.

2.06.00 **Control of Alignment, Level and Surface Regularity**

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for roadworks are described hereinafter.

i) **Horizontal Alignments**

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of± 10 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be± 25 mm.

ii) **Surface Levels**

The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer beyond the tolerances mentioned in Table1.

TABLE-1.

TOLERANCES IN SURFACE LEVELS
(Table 900-1 of MORT&H)

1.	Subgrade			+ 20 mm - 25 mm
2.	Sub-base + 10 mm :			
	a)	Flexible pavement		- 20 mm
	b)	Concrete pavement (Dry lean concrete or Rolled concrete)		+ 6 mm - 10 mm
3.	Base-course for flexible pavement			
	a)	Bituminous course		+ 6 mm - 6 mm
	b)	Other than bituminous		+ 10 mm
		i)	Machine laid	- 10 mm + 15 mm
		ii)	Manually laid	- 15 mm

4.	Wearing course for flexible pavement :		
	a)	Machine laid	+ 6 mm - 6 mm
	b)	Manually laid	+10 mm -10 mm
5.	Cement concrete pavement		+ 5 mm - 6 mm *

* This may not exceed - 8 mm at 0- 30 cm from the edges.

Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course, if the thickness of the former is thereby reduced by more than 6 mm for flexible pavements and 5 mm for concrete pavements.

For checking compliance with the above requirement for subgrade, sub-base and base courses, measurements of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance.

TABLE-2

MAXIMUM PERMITTED NUMBER OF SURFACE IRREGULARITIES
(Table 900-2 of MORT & H)

	Surfaces of Carriageways and paved shoulders				Surfaces of laybys, service areas and all bituminous base courses			
Irregularity	4mm		7mm		4mm		7mm	
Length (m)	300	75	300	75	300	75	300	75
National Highways/ Expressways*	20	9	2	1	40	18	4	2
Roads of lower category*	40	18	4	2	60	27	6	3

*Category of each section of road as described in the Contract.

The maximum allowable difference between the road surface and underside of a 3 m straight-edge when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be:

for pavement surface (bituminous and cement concrete)	3 mm
for bituminous base courses	6 mm
for granular sub-base/base courses	8 mm
for sub-bases under concrete pavements	10 mm

2.07.00 **Rectification**

Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

i) Subgrade : Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirements of Clause 305 of MORT&H.

ii) Granular sub-base: Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the requirements of Clause 401 of MORT&H.

iii) Water Bound Macadam/Wet Mix Macadam Sub-base/Base: Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted to Clause 404. This shall also apply to wet mix macadam to Clause 406 of MORT&H.

iv) Bituminous Constructions: For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat if needed and recompacting to specifications. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 m in length and not less that 3.5 m in width.

2.08.00 **Quality Control Tests During Construction**

As per Clause 903 of MORT&H specification.

3.00.00 **EXECUTION**

3.01.00 **Shoulder**

3.01.01 **Description**

This work shall consist of constructing shoulders on either side of the pavement in accordance with the requirements of MORT&H specification and in conformity with the lines, grades and cross- sections shown on the drawings or as directed by the Engineer.

3.01.02 **Materials**

Shoulder may be of selected earth/ granular material/paved conforming to the requirements of MORT&H specification.

3.01.03 **Construction Operations**

Shoulder

The sequence of operations shall be such that the construction of paved shoulder is done in layers each matching the thickness of adjoining pavement layer. Only after a layer of pavement and corresponding layers in paved and earth shoulder portion have been laid and compacted, the construction of next layer of pavement and shoulder shall be taken up.

Where the materials in adjacent layers are different, these shall be laid together and the pavement layer shall be compacted first. The corresponding layer in paved shoulder portion shall be compacted thereafter, which shall be followed by compaction of earth shoulder layer. The adjacent layers having same material shall be laid and compacted together.

Compaction requirement of earthen shoulder shall be as per latest MORT&H specification. In the case of bituminous course, work on shoulder (earthen/hard/paved), shall start only after the pavement course has been laid and compacted.

During all stages of shoulder (earthen/hard/paved) construction, the required crossfall shall be maintained to drain off surface water.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement, and the area so affected thoroughly cleaned.

3.02.00 **Sub-base (Granular Sub-base)**

3.02.01 **Description**

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of MORT&H specifications. The material shall be laid in one or more layers as shown on the drawings and according to lines, grades and cross sections shown on the drawings or as directed by the Engineer.

3.02.02 **Materials**

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table 3.

While the gradings in Table 3 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding gradings for the coarse-graded materials for each of the three maximum particle sizes are given at Table 4. The grading to be adopted for a project shall be as specified in the Contract.

TABLE-3

GRADING FOR CLOSE-GRADED GRANULAR SUB-BASE MATERIALS (TABLE 400-1 of MORT&H)

IS Sieve Designation	Per cent by weight passing the IS sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm	80-100	100	-
26.5 mm	55-90	70-100	100
9.50 mm	35-65	50-80	65-95
4.75 mm	25-55	40-65	50-80
2.36 mm	20-40	30-50	40-65
0.425 mm	10-25	15-25	20-35
0.075 mm	3-10	3-10	3-10
CBR Value (Minimum)	30	25	20

TABLE-4

GRADING FOR COARSE GRADED GRANULAR SUB-BASE MATERIALS
(Table 400-2 of MORT&H)

IS Sieve Designation	Per cent by weight passing the IS Sieve		
	Grading I	Grading II	Grading III
75.0 mm	100	-	-
53.0 mm		100	
26.5 mm	55-75	50-80	100
9.50 mm			
4.75 mm	10-30	15-35	25-45
2.36 mm			
0.425 mm			
0.075 mm	<10	<10	<10
CBR Value (Minimum)	30	25	20

Note : The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 percent respectively.

3.03.03 **Physical Requirements**

The material shall have a 10 per cent fines value of 50 kN or more (for sample in soaked condition) when tested in compliance with BS: 812 (Part III). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 383. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which be taken as being the density relating to a uniform air voids content of 5 percent.

3.03.04 **Spreading and Compacting**

The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (Part II) and suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part VIII). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 95% of the maximum dry density for the material determined as per IS: 2720 (Part VII). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

3.04.00 **Water Bound Macadam Sub-base/Base Course**

3.04.01 **Description**

Water bound macadam shall consist of clean, crushed aggregates mechanically interlocked by rolling,, and bonded together with screenings, binding material, where necessary and water, laid on a prepared subgrade or sub-base, as the case may be, and finished in accordance with the requirements of MORT&H Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the Engineer.

3.04.02 **Materials**

3.04.02.1 **Coarse Aggregates**

Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates or any other naturally occurring aggregates such as kankar and laterite of suitable quantity. The aggregates shall conform to the physical requirements set forth in Table 5.

TABLE 5 (Table 400-6 of MORT&H)

PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE/BASE COURSES

	Test	Test Method	Requirements
1.	* Los Angeles Abrasion value Or * Aggregate Impact value	IS : 2386 (Part-4) IS : 2386 (Part-4) or IS : 5640 **	40 per cent (Max) 30 per cent (Max)
2.	Combined Flakiness and Elongation Indices (Total) ***	IS : 2386 (Part-1)	30 per cent (Max)

* Aggregate may satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar, laterite etc. which get softened in presence of water shall be tested for Impact value under wet conditions in accordance with IS : 5640.

*** The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

3.04.02.2 **Crushed or Broken Stone**

Crushed or broken stone shall be hard, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter.

3.04.02.3 **Grading Requirements of Coarse Aggregates**

The coarse aggregates shall conform to one of the gradings given in Table 6, provided, however, the use of Grading No. 1 shall be restricted to sub-base courses only.

TABLE 6 (Table 400-8 of MORT&H)

GRADING REQUIREMENTS OF COARSE AGGREGATES

Grading No.	Size Range	IS Sieve Designation	Per cent by Weight passing
1.	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60
		45 mm	0-15
		22.4 mm	0-5
2.			
	63 mm to 45 mm	90 mm	100
		63 mm	90-100
		53 mm	25-75
		45 mm	0-15
		22.4 mm	0-5
3.	53 mm to 22.4 mm	63 mm	100
		53 mm	95-100
		45 mm	65-90
		22.4 mm	0-10
		11.2 mm	0-5

Note : The compacted thickness for a layer with Grading 1 shall be 100 mm while for layer with other Gradings e.g. 2 & 3, it shall be 75 mm.

3.04.02.4 **Screenings**

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

Screenings shall conform to the gradings set forth in Table7.

TABLE 7

GRADINGS FOR SCREENINGS (Table 400-8 of MORT&H)

Grading Classification	Size of Screenings	IS Sieve Designation	Per cent by weight passing the IS Sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95-100
		5.6 mm	15-35
		180 micron	0-10
B	11.2 mm	11.2 mm	100
		5.6 mm	90-100
		180 micron	15-35

3.04.02.5 **Binding Material**

Binding material to be used for water bound macadam as a filter material meant for preventing ravelling, shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS : 2720 (Part-5).

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06-0.09 m3/10m2 and 0.08-0.10m3/10m2 for 100 mm compacted thickness.

The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction etc.

Application of binding materials may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.04.03 **Construction Operations**

3.04.03.1 **Preparation of Base**

The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water.

3.04.03.2 **Inverted Choke**

If the water bound macadam is to be laid directly over the subgrade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) shall be spread on the prepared subgrade before application of the coarse aggregates is taken up.

3.04.03.3 **Spreading Coarse Aggregate**

The coarse aggregates shall be spread uniformly upon the prepared surface in such quantities that the thickness of the compacted layer is 100 mm for grading 1 and 75-100 mm for gradings 2 and 3 for each layer.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

3.04.03.4 **Rolling**

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 80 to 100 kN capacity or tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to make up depressions.

3.04.03.5 **Applications of Screenings**

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreaders, or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

3.04.03.6 **Sprinkling and Grouting**

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly.

The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

3.04.03.7 **Application of Binding Material**

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

3.04.03.8 **Setting and Drying**

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.05.00 **Tack Coat**

3.05.01 **Description**

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing bituminous road surface preparatory to the superimposition of bituminous mix, when specified in the Contract or instructed by the Engineer.

3.05.02 **Materials**

Binder: The binder used for tack coat shall be bitumen emulsion complying with IS: 8887 of a type and grade as specified in the Contract or as directed by the Engineer.

3.05.03 **Construction Operations**

3.05.03.1 **Preparation of Base**

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt and any extraneous material. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom and high pressure air jet, or by other means as directed by the Engineer.

3.05.03.2 **Application of tack coat**

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. The normal range of spraying temperature for a bituminous emulsion shall be 20 degree Celsius - 70 degree Celsius and for a cutback 50 degree Celsius – 80 degree Celsius if RC-70/MC-70 grade is used. The method of application of the tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed of forward movement. The contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

3.06.00 **Bituminous Macadam Binder Course**

3.06.01 **Description**

This work shall consist of construction, in a single course, of 50 mm to 100 mm thickness or in multiple courses of compacted crushed aggregates premixed with a bituminous binder on a previously prepared base to the requirements of MORT&H Specifications.

3.06.02 **Materials**

3.06.02.1 **Bitumen**

The bitumen shall be paving bitumen of penetration grade complying with Indian Standard Specifications for “Paving Bitumin”IS: 73, and of the penetration indicated in table 500-4 of MORT&H

3.06.02.2 **Coarse Aggregates**

The aggregates shall consist of crushed stone, crushed gravel or other hard material retained on the 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious matter. Where crushed gravel is used, not less than 90 per cent by weight of the crushed material retained on 4.75 mm sieve shall have at least two fractured faces.

The aggregates shall satisfy the physical requirements set forth in Table 8.

TABLE 8 (Table 500-3 of MORT&H)

PHYSICAL REQUIREMENTS FOR COARSE AGGREGATES FOR BITUMINOUS MACADAM

Property	Test	Specification
Cleanliness	Grain size analysis	Max 5 % passing 0.075 mm sieve
Particle shape	Flakiness and Elongation Index (combined)2	Max 30%
Strength	Los Angeles Abrasion Value Aggregate Impact Value	Max 40% Max 30%
Durability	Soundness : Sodium Sulphate Magnesium Sulphate	 Max 12% Max 18%
Water Absorption	Water Absorption	Max 2%
Stripping	Coating and Stripping of Bitumen Aggregate Mixtures	Minimum retained coating 95%
Water Sensitivity	Retained Tensile Strength	Min 80%

3.06.02.3 **Fine aggregates**

Fine aggregates shall consist of crushed or naturally occurring material, or a combination of the two, passing 2.36 mm sieve and retained on 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter

3.06.02.4 **Proportioning of Materials**

The aggregates shall be proportioned and blended to produce a uniform mixture complying with the requirements of table 500-4 of MORT&H.The binder content shall be within a tolerance of

3.06.03 **Construction Operations**

3.06.03.1 **Weather and Seasonal Limitations**

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

3.06.03.2 **Preparation of Base**

The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

3.06.03.3 **Tack Coat**

A tack coat shall be applied over the base.

3.06.03.4 **Preparation and Transport of Mix**

It would be carried out as per Clause 501.3 and 501.4 of MORT&H

3.06.03.5 **Spreading**

It would be carried out as per Clause 501.5.3 of MORT&H.

3.06.03.6 **Rolling**

It would be carried out in accordance with the provisions of Clauses 501.6 and 501.7 of MORT&H.

3.07.00 **Bituminous Concrete**

3.07.01 **Scope**

This clause specifies the construction of bituminous concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25 mm to 100 mm in thickness.

3.07.02 **Materials**

3.07.02.1 **Bitumen**

The bitumen shall be paving bitumen of penetration grade complying with Indian Standard Specification for Paving Bitumen. IS:73 and of the penetration indicated in Table 500-18 of MORT&H, for bituminous concrete or this bitumen as modified by one of the methods specified in clause 521 of MORT&H, or as otherwise specified in the contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

3.07.02.2 **Coarse Aggregates**

The coarse aggregates shall be generally as specified in clause 507.2.2 of MORT&H, except that the aggregates shall satisfy the physical requirements of Table 500-17 of MORT&H.

3.07.02.3 **Fine Aggregates**

The fine aggregates shall be all as specified in clause 507.2.3 of MORT&H.

3.07.02.4 **Filler**

Filler shall be generally as specified in clause 507.2.4 of MORT&H. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-17 of MORT&H then 2 percent by total weight of aggregate, of hydrated lime shall be added without additional cost.

3.07.02.5 **Aggregate grading and binder content**

When tested in accordance with IS:2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall

Within the limits shown in Table 500-18 of MORT&H for gradings 1 or 2 as specified in the Contract.

3.07.03 **Mixture Design**

3.07.03.1 **Requirements for the mixture**

Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-19 of MORT&H.

The requirements for minimum percent voids in mineral aggregate (VMA) are set out in Table 500-12 of MORT&H.

3.07.03.2 **Binder content**

The binder content shall be optimised to achieve the requirements of the mixture

Set out in Table 500-19 of MORT&H and the traffic volume as specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Engineer.

3.07.03.3 **Job mix formula**

The procedure for formulating the job mix formula shall be generally as specified in clause 507.3.3 of MORT&H and the results of tests enumerated in Table 500-19 of MORT&H as obtained by the Contractors.

3.07.03.4 **Plant trials-permissible variation in job mix formula**

The requirements for plant trials shall be all as specified in clause 507.3.3 of MORT&H and the results of tests enumerated in Table 500-19 as obtained by the contractors.

3.07.03.5 **Laying trials**

The requirements for plant trials shall be all as specified in clause 507.3.5 of MORT&H.

3.07.04 **Construction Operations**

3.07.04.01 Weather and seasonal limitations

The provisions of clause 501.5.1 of MORT&H shall apply.

3.07.04.02 **Preparation of base**

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with clauses 501 and 902 of MORT&H as appropriate, or as directed by the engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the engineer.

3.07.04.03 **Tack coat**

Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of clause 503 of MORT&H.

3.07.04.04 Mixing and transportation of the mixture

The provisions as specified in clauses 501.3 and 501.5.4 of MORT&H shall apply.

3.07.04.05 **Spreading**

The general provisions of clauses 501.5.3 and 501.5.4 of MORT&H shall apply.

3.07.04.06 **Rolling**

The general provisions of clauses 501.6 and 501.7 of MORT&H shall apply, as modified by the approved laying trials.

3.07.05 **Opening to traffic**

The newly laid surface shall not be open to traffic for at least 24 hours after laying and the completion of compaction, without the express approval of the engineer in writing.

3.07.06 **Surface finish and Quality control**

The surface finish of the completed construction shall conform to the requirements of clause 902 of MORT&H. All materials and workmanship shall comply with the provisions set out in section 900 of this specification.

3.07.07 **Arrangements for traffic**

During the period of construction, arrangements for traffic shall bemade in accordance with the provisions of clause 112 of MORT&H.

3.08.00 **Road Side Drains**

3.08.01 **Formation of Drains**

The road side drains shall be made in sizes and slopes as shown on drawings and/or as instructed by the Engineer. The minimum side slope shall be as instructed by the Engineer. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts, outside plant area, as per instructions of the Engineer.

The excavated spoils shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per Dwg.

3.09.00 **Culverts**

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Engineer after clearing the site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed, as applicable.

3.10.00 **Pipe Culverts and Drainage Pipes**

3.10.01 **Materials**

The drainage pipes unless otherwise shown on drawings or instructed by the Engineer shall be made of R.C.C. and shall be either Class NP2 or NP3.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP3 or of RDSO class for railway as decided by the Engineer or shown in the drawing. All pipes shall meet the requirements of IS:458-Latest edition and shall be procured from approved manufacturers with collars as per manufacturer's standard specifications. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland cement as per IS: 8112 - Latest edition.

Aggregates shall be as per IS: 383 - Latest edition - Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller.

Fine aggregates for concrete shall be as per IS: 383 - Latest edition.

3.10.02 **Laying of Pipes**

Laying of concrete pipes shall correspond to IS:783 - Latest edition - and to specification given below :

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Engineer. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor more than one-third the diameter of pipe unless otherwise instructed/ permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water, etc. as required shall be done by the Contractor without any extra cost to the Owner. Side slips, if there be any, shall be removed by the Contractor without any extra cost to the Owner. After laying of the pipes are completed, backfilling of the trenches shall be done in 250 mm layers, measured loose clods and lumps

broken, watered and compacted with iron rammers to the satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area, as instructed by the Engineer.

When bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 - Latest edition - having a projection ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height, and in which earth filling material is thoroughly rammed and tamped in layers not exceeding 15 cm in depth around the pipe for the remainder of the lower 30 percent of its height.

If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS: 783.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a craddle constructed of concrete having a mix not leaner than M25. The shape and dimension of the cradle shall be as indicated on the drawing or directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete has set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care regarding the invert of the pipe, gradient, if any, etc. as specified on drawings and/or as instructed by the Engineer.

e) Where R.C.C. pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and remaining height of block to be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for workability. Procedure of jointing shall be as per IS:783 - latest edition.

3.10.03 **Relation with Water Supply Pipeline**

Unless specifically cleared by the Engineer, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

3.11.00 **Manholes and Inspection Chambers**

The maximum distance between manholes shall be 30 meter unless specifically permitted otherwise. In addition at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be watertight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole.

Manholes shall be provided with standard covers, usually C.I. or as directed by the Engineer. The covers shall be close fitting so as to prevent gases from coming out.

3.12.00 **Plaster to Concrete**

Before application of plaster the surface shall be cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess water shall be mopped up.

Unless otherwise mentioned in the schedule of items plastering shall be done with cement sand mortar - 1 part by volume of cement to 4 parts by volume of clean, sharp, well graded sand. For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency. For lime gauge plaster, lime putty or hydrated lime and sand in the required proportion shall

be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No mortar which has stood for more than half an hour shall be used.

Plaster, when more than 12 mm thick, shall be applied in two coats. All plaster work shall correspond to IS: 1661- latest edition.

3.12.01 **Finish**

Generally, all plastered surfaces shall have a standard finish unless otherwise shown on the drawing or directed by the Engineer. The interior plaster shall be finished to a smooth surface by steel trowelling. The exterior surfaces shall be finished with a wooden float.

However, if shown on the drawing or directed by the Engineer the plastered surface shall have a neat cement finish. Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg per Sq.M. and rubbed smooth with a trowel.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 Roads

All testing, as mentioned in the body of the specification and as mentioned in section 900 of MORT&H shall be carried out by the Contractor as per direction of the Engineer. No extra payment shall be made for such tests.

4.02.00 Cement Concrete

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS: 456.

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SECTION-I

TECHNICAL SPECIFICATION
FOR
LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

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SECTION-I

TECHNICAL SPECIFICATION FOR LAND SURVEY AND ESTABLISHING REFERENCE GRIDS AND BENCH MARK PILLARS

1.0 SCOPE

This specification is intended to cover topographical surveys and preparation of plans (maps) showing all permanent features including buildings, large trees, pucca & kutchha nullas, ditches, (with or without water), nearby roads / approaches, railway track, culverts, overhead transmission & communication lines, ridges, boundary wall, fencing, demarcation line etc. of the project area as well as sectional views of the drains, ditches, creek, culverts and similar items (with all dimensions and invert levels). Carrying of the Bench Mark (existing reference BM outside the project area) to project site by levelling, establishing bench marks and grids in the field, spot level survey at specified intervals and on change points, contouring, constructing and fixing of bench mark pillars & grid pillars in the field, clearing of jungles & debris and cutting of trees (to the minimum extent as required for the work and as per instruction of the Owner) etc. shall also form a part of the scope of work. In addition, the true north, magnetic north and the angle between the grid lines (established at site) and the true north or magnetic north shall be indicated in all drawings.

It may also be necessary to interconnect the existing grid lines (with measured angles and distances) and level references as well as a few permanent buildings and permanent roads adjacent / near the specified project site area during the proposed survey work and thus incorporate the same in the survey plans / maps.

The drawing no 13A06-DWG-M-001 (Plot Plan) gives location of the project and an indication of the project area to be surveyed. These drawings are preliminary and do not cover the entire scope of work. These may be modified, survey area increased / decreased, and any new drawing may be given before award of the Work or during execution of the work (keeping sufficient time for field survey work and plotting).

Permanent features and levels of a few existing items as given in the above drawings shall not be used as reference without verification by actual survey with precision instruments by the contractor and plotted in his maps / drawings accordingly.

The grid pillars and B.M. pillars shall be maintained and checked frequently to ensure the correctness of the value of the pillar till the completion of the job and handing them over to the Owner. It shall be responsibility of the Contractor to check the pillars jointly with Owner / Engineer at the time of final handing over of the work to the Owner.

The tenderers should visit the project site, at his own cost, before quoting rates for this tender. No extra claim (in terms of extension of time or revision in rates, etc.) shall be entertained at a later date on the ground of insufficient knowledge about the site or for lack of clarifications on this specification.

2.0 GENERAL

2.1 Work to be Provided for by the Contractor

2.1 Work to be provided by the Contractor, unless specified otherwise, shall include but not be limited to the following :

a) Furnish necessary instruments and all other tools and materials including pegs, marking plates for reference grid and bench mark pillars, construction materials for pillars, labour & skilled surveyors, supervision by competent engineers, services, necessary transport, full insurance and all other incidental items as may be necessary for on-time and successful completion of the surveying and mapping work.

b) Furnish original field & level books, notes taken on special features and field drawings with readings & relevant features plotted.

c) Preparation, thorough checking & cross checking in the field and submission of completed survey plans / maps and drawings in specified scale incorporating sectional views and details as included under Section - 1.0.

d) Construction and installation of reference grids and bench mark pillars at specified locations.

2.2 Work to be provided for by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.3 **Information to be Submitted by the Tenderer.**

2.3.1 **With Tender**

The tenderer shall indicate in his tender the number of different surveying instruments (with make and year of manufacture), skilled & experienced surveyors, and competent engineers that will be deployed at the site for this work. His experience during last five years in similar survey work shall be detailed in the tenderer's offer which shall also include his present commitments.

2.3.2 **After Award**

The contractor shall inform and satisfy the Engineer regarding deploymet of personnel engaged by him for quality work under an agreed time-frame for completion of the work under this Contract.

He shall also prepare, discuss with Owner / Engineer and submit an agreed work programme within seven (7) days of award of the Work and during which period he shall also mobilize his instruments, tools, personnel at the project site.

The survey documents shall be submitted to the Owner / Engineer by the Contractor progressively during execution of the Work in order to enable him to review the work and, if necessary, cross-check at site along with Contractor's surveyor and engineer and point out the deficiencies / discrepancies, if any, therein. However, the Contractor shall be still responsible for the correctness of the entire work and shall resurvey and replot any portion of the Work which may be found to be defective later on. During such checking / cross-checking as well as supervision during execution of the entire work, the Contractor shall extend all facilities including proper instruments, tools, other materials, surveyors & labour, etc. to the Owner / Engineer.

The Contractor shall engage qualified engineers, surveyors, drafting persons, etc. for executing the work under this Contract.

3.0 INSTRUMENTS AND CONSTRUCTION MATERIALS

3.1 **Instruments**

The entire field surveying shall be done with the combination of transit / optic Theodolites (which can read upto 20 seconds or less), Prismatic Compass, Precision Levelling Instruments with well-graduated & accurate staff, Chain, Measuring Steel Tapes and Plane Table Survey by Clenometer with the help of Clenograph Scale, ranging rods, etc.

Theodolite should be optically centred and the levels should be tilting type. Measuring tapes shall be used with calibrated tension. The calibration charts for the instruments shall be submitted before the start of the Work.

High quality surveying instruments (particularly, theodolites & levels) of reputed manufacturers shall be deployed for accurate and dependable survey work. Electronic instruments, if available with the Contractor, will be preferred.

3.2 Construction Materials for Reference Grid and Bench Mark Pillars

Concrete for pillars shall be of mix 1:2:4 (one cement : two coarse sand : four 20 mm down stone aggregates). All the component materials shall be of best & acceptable quality and conforming to the provisions of the latest version of the Indian Standards.

Steel plates for engraving B.M. value and reference grids shall be of mild steel, conforming to IS : 2062.

4.0 EXECUTION

4.1 Permanent Adjustments

All permanent adjustments of the instruments shall be made before starting the work, to the satisfaction of the Owner / Engineer.

4.2 Contour Intervals and Scale of Drawings

4.2.1 Contour Intervals

For contouring, spot levels shall be taken at 10 m horizontal intervals or less in both directions to establish the contours at 300 mm intervals for nearly flat terrains and at 0.5 m to 1.0 m intervals for undulating hilly terrains, as per schedule of items and direction of the Owner / Engineer.

4.2.2 Scale of Drawings

Depending upon the area to be covered, survey maps shall be prepared in the scale of 1 : 500 or 1 : 1000, as indicated in Schedule of Items, and all permanent features (as indicated under Section - 1.0), grid pillars, bench mark pillars, reference grid and bench mark pillars, contours (as specified in 4.2.1 above) etc. shall be plotted.

Sectional views of the drains, ditches, culverts, roads, etc., however, can be prepared in a scale suitable for furnishing all pertinent dimensions, levels and information, and in a separate drawing sheet.

4.3 **Submission of Drawings and Documents**

The following documents shall submitted to the Owner / Engineer :

4.3.1 Original field and level books and notes taken on special features, plus a photo-copy each of the above documents.

4.3.2 Field drawings with readings and relevant features and sectional views plotted - three (3) copies for review by Owner / Engineer. (One copy will be returned to the Contractor with comments, if any).

4.3.3 Original and one (1) copy of the above field drawings (item 4.3.2 above) after field verification of the comments and incorporating the corrected features.

4.3.4 Original tracing and four (4) prints of the final survey maps and drawings showing other details, all prepared in ink and in clear legible form. Format of and title block on the drawing / map shall be as per direction of Owner / Engineer.

4.4 **Time of Completion**

Time shall be deemed to be the essence of the Contract. The entire survey work including submission of the final survey maps and drawings as well as other documents (ref. : 4.3 above) shall be completed within a period of weeks / months in the following manner :

a)	Mobilisation and firming up time schedule and survey groups...	:	1 week
b)	Completion of field survey work and submission of three (3) copies of the field drawings and a photo-copy of the field & level books and the field notes, etc. (Items 4.3.1 & 4.3.2 above).	:	6 weeks
c)	Submission of the final survey maps & drawings and other documents (item 4.3.1, 4.3.3 & 4.3.4 above).	:	2 weeks

Construction and installation of grid and bench marks pillars, however, are to be subsequently completed within 2 weeks of the clearance from Owner / Engineer.

If the Owner / Engineer feels that the progress of the work is not satisfactory, he shall notify the Contractor to take necessary measures to complete the Work on time. If the Contractor fails to comply with the Owner's directive or fails to complete the Work on time, Owner will be at liberty to get the Work done by any other agency and forfeit the amount related to unfinished works and the Earnest Money / Security Deposit of the Contractor.

4.5 **Security Rules and Statutory Regulations**

The Contractor shall strictly follow at site all security rules and regulations enforced by Owner from time to time regarding movement of materials, equipment / instrument, personnel to and from site, issue of identity cards, badges, control of entry and all similar matters.

The Contractor, his employees and agents shall not disclose any information or drawings prepared by him or furnished to him by the Owner / Engineer.

He shall also follow all safety rules and regulations and shall take sufficient measures to adhere to the same.

The Contractor shall conform in all respects with the provisions of any statute, ordinance law, rules, regulations, by-laws of Central, State, Local or other duly constituted Authority. The Contractor shall give all notices and fees to be given or paid.

In respect of labour, the Contractor shall comply with all rules framed by the Government for the protection of health, wages, welfare and safety of the workers. The Contractor shall be responsible for effective insurance under the Indian Workman's Compensation Act., Third Party Liability Insurance, etc. in accordance with the Indian Law and Regulation at his own cost.

In fine, the Contractor shall keep the Owner and Engineer indemnified against all penalties and liabilities of every kind.

5.0 TECHNICAL SPECIFICATIONS

5.1 Establishing of Bench Marks

At least two permanent bench marks at each site at approved locations shall be established from the existing bench marks. While carrying the bench mark, levels shall be established on permanent objects as directed by the Engineer. Levelling survey shall be done in the forward and reverse direction and the closing error should not be more than $\pm$ 05 mm.

5.2 Establishing of Grid Pillars

Permanent grid pillars shall be established in either direction at every 100 m intervals or as directed. *One reference pillar and one reference grid direction shall be provided by the Owner. For carrying reference pillars, additional station points shall be established for traversing or triangulation as directed by the Engineer. The closing error for any closed traverse shall not exceed the specified limits as per clause 5.6. The maximum tolerance for any grid location shall be $\pm$ 1 mm. Generally for all angular measurements, transit of theodolite shall be done. Measurement shall be verified by cross-checking the diagonal angle as directed by the Engineer. For observing bearing from magnetic north, care should be taken that no magnetic substance to influence the bearing reading is there. The magnetic north should also be periodically verified.

Reference shall be taken from the existing permanent objects identifying from the Cadestal map for establishing the new grid line and shall be related to true north line where grids are not existing.

5.3 **Reference Grid Pillars and Bench Marks**

All reference grid pillars and permanent bench marks shall be 900 mm x 200 mm x 200 mm cement-concrete pillars with 150 mm projecting above ground. 150 mm square x 12 mm thick steel plates (with two L-shaped 20 cm long M.S. lugs welded to the plate) or 6 mm thick aluminium plates with bolts shall be embedded or bolted on top of the pillars. Grid points & lines shall be accurately punched on the plates as also the numerical values of grid lines and levels. Grid lines and levels as required shall be painted.

5.4 **Topographical Surveying and Mapping**

Positions, both in plan and elevation, of all natural and artificial features of the area in question (including permanent objects) are to be established and subsequently delineating them on survey maps by means of conventional symbols (preferably those of Survey of India maps). Necessary levelling work of the project area shall be combined with methods of establishing horizontal location so that location and sketching of contours for the area can be done at specified intervals and in specified scales on maps. Rock outcrops, springs / falls (if any) and other unusual ground formations / conditions shall be noted and locations plotted on the maps.

The field work shall be done in the following steps :

a) Establishing horizontal and vertical controls and locating reference grids and bench marks in the area.

b) Levelling and plotting contours.

c) Surveying and locating the natural, artificial and permanent features in details as described earlier.

d) Taking of longitudinal and cross-sections of the corridors for pipe line and road / rail and drains, ditches, water bodies, culverts, etc.

All survey work shall be related with true north and true north shall be established at site beforehand.

5.5 **Traversing and Ground Controls**

Triangulation or Traversing or a combination of the two methods shall be adopted for the purpose of establishing horizontal controls, in order to determine the exact relationships between various existing points / features on ground, so that surveys required under the present scope of work and in future may be correlated and tied together.

Before commencement of work, the plan showing base lines and the grid lines and their spacings shall be got approved by the Owner / Engineer at site. First, a traverse covering the entire survey area shall be established with reference to a permanent object / reference grid pillar already existing at Site (as instructed by the Owner / Engineer).

The closing error in traverse (primary / secondary) shall not exceed one in three thousand in terms of length or, L $\sqrt{N}$ second (total) in angular measurement, whichever is less. (Where, L = the least count of the instrument and N = the number of stations).

5.6 **Contouring**

Spot level surveying at specified intervals shall be adopted for contouring the area, so that accurate contouring can be done. At places of sharp curvature or abrupt changes in direction and elevation, points selected shall be close to represent the actual ground configuration.

Levelling operation shall always start on a control station / nearby bench mark and end on the same.

5.7 **Route Survey**

Route Survey shall be conducted along a narrow strip / belt of the terrain selected after field reconnaissance or as directed by Owner / Engineer at Site. Topographical survey for existing storm drainage lines as well as for routing pipe lines, transportation and communication lines, etc. shall be conducted. Longitudinal profiles as well as cross-sections shall be taken at 50 m intervals or less in nearly flat / undulating terrains and at 20 m intervals in hilly terrains, as per direction of the owner / Engineer. All cross-sections shall be with reference to centre line of corridor showing levels at every 2 - 5 metre intervals and all breaks in the profile. The width of strip / corridor shall be as specified in the drawing or as directed by Owner / Engineer.

6.0 RATES

The rates for the items of land survey and establishing reference grids and bench mark pillars shall include the cost of materials consumed in this work or incidental to it, the cost of instruments, tools and plants, labour, supervision, transport, installation, taxes, insurance, royalties and revenue expenses, security and safety measures, approaches, power, fuel, services, preliminary and enabling works, camps, stores, water, etc. and overheads & profits complete. In case no specific item is provided in the schedule to cover any particular item of work, it is implied that the contractor will include the cost of executing such work in the rates quoted for connected items in the schedule.

7.0 METHOD OF MEASUREMENT

Unless specified otherwise in the schedule of items, the measurement of items shall be done as follows :

7.1.0 Carrying and Establishment of Bench Mark (B.M.)

Carrying of the bench mark from nearby available permanent B.M. to site (at boundary point) shall be measured in running kilometre along the route of survey passing over all kinds of ground conditions which includes levelling, establishing bench marks, complete as per specification. Supply and installation of B.M. pillars shall be measured separately.

7.2.0 Topographic Survey

Areas of topographic survey shall be measured in Hectare which includes surveying and plotting of topographic features, physical features of all objects, areas of shallow water bodies, pucca & kutcha nallas, ditches, nearby roads / approaches, railway tracks, culverts, overhead transmission & communication lines and supports, ridges, etc., levelling and establishing grid lines complete as per specification. Supply and installation of grid pillars shall be measured separately.

7.3.0 Route Survey

Area of route survey shall be measured in Hectare for the specified corridor width of land which includes surveying and plotting of topographic features, physical features of all objects, pucca & kutcha nallas, ditches (with or without water), roads / approaches, railway tracks, overhead transmission & communication lines, and supports, ridges, etc., levelling and establishing grid lines complete as per specification. Supply and installation of grid pillars shall be measured seperately.

7.4.0 Bench Mark Pillars and Grid Pillars

Pillars shall be measured in number as per specification and schedule of items.

VOLUME – II B

SECTION – D

SUB SECTION – D23

ANTI-TERMITE TREATMENT

SPECIFICATION NO. PE-TS-999-600-C023

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

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TECHNICAL SPECIFICATION FOR ANTI-TERMITE TREATMENT

1.00.00 SCOPE

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.00.00 EXECUTION

2.01.00 General

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.
All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.
Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.02.00 Chemicals and Rate of Application

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

Chemicals		Concentration by Weight, Percentage
Chlorpyrifos Emulsifiable (IS 8944 - 1978)	:	1.0
Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978)	:	0.5
Chlordane Emulsifiable Concentrate (IS: 2682 - 1984)	:	1.0

2.02.01 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M^2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / M^2 of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by

rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

2.02.02 Treatment of Top Surface of Plinth Filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M^2 of surface shall be applied prior to laying soling or sub-grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.02.03 Treatment of Soil Surrounding Pipes, Wastes and Conduits

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.02.04 Treatment of Expansion Joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.02.05 Treatment at Junction of the Wall and the Floor

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from ground level up to the level of the filled earth surface.
A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.00.00 ACCEPTANCE CRITERIA

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.

4.00.00 RATES

Rates shall be of complete work per unit area as stated in the Schedule.

5.00.00 METHOD OF MEASUREMENT

Complete work of anti-termite treatment shall be measured for plinth area treated.

This includes treatment, to foundations, walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work.

6.00.00 I.S. CODE

Relevant code applicable for this Specification.

IS: 6313 (Part-II) 1981 : Code of Practice of Anti-Termite Measures in Buildings
Pre-constructional chemical treatment measures.

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SECTION - D

SUB-SECTION – D3

CARPENTRY AND JOINERY

SPECIFICATION NO. PE-TS-999-600-C003

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

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CARPENTRY AND JOINERY

1.00.00 SCOPE

This section covers supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, flush doors, windows, shutters, partitions, wall panelling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate where called for. This shall also include the supply and fixing of all hardware and fixtures shown in drawing or specified.

2.00.00 INSTALLATION

2.00.01 Materials

a) Timber

Unless otherwise specified, all timber shall be best quality well seasoned CP teakwood free from large or loose knots, cracks or any other defects. All timber shall be treated with approved wood preservative before use, unless specified otherwise. The rough timber shall be approved by the Engineer before incorporating in the works and starting the carpenter's work.

b) Plywood

Plywood shall be of commercial quality or with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol formaldehyde synthetic resin of BWP grade conforming to IS: 848.

c) Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer. The bulk supply shall be procured in full sheet sizes which will ensure the least number or joints in one surface.

d) Flush Doors

Flush doors shall be solid core doors with commercial or decorative faces and hardwood edges conforming to IS: 2202 (Part-1). The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is BWP grade phenol formaldehyde synthetic resin conforming to IS: 848. The thickness shall be as specified.

e) Panel Doors

Panel door shall be of teakwood shutter frame, unless otherwise noted and panels with teakwood/commercial ply/teakwood particle board. Other considerations shall be as mentioned in item (d) above.

f) Windows, Ventilators

Windows and ventilators shall made of teakwood shutter frame, unless specified otherwise and glazing of specified thickness shall be fixed with wooden beadings.

g) Fixtures

Fixtures for doors, windows, furniture etc. shall be as shown on drawing or specified.

2.02.00 Workmanship

2.02.01 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close - fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc., which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood, which will be subsequently polished. Screwing or nailing will not be permitted to the edge of plywood and particle board. The edge of all plywood, blackboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing to frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete. The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M.S. grills or guard bars shall be provided to windows where called for in the drawings.

2.02.02 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those, which shall be subsequently polished or covered with laminated plastic sheet.

2.02.03 Surface Treatment

When shown on drawings or called for, decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or bevelled as shown on drawings.

3.00.00 ACCEPTANCE CRITERIA

3.00.01 Door and Window Frames

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.02.00 Door and Window Shutters

All doors and window shutters shall be of proper size, shape, and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.03.00 Partitions, Paneling, Pelmets, Furniture, etc.

3.03.01 General

These shall conform to drawings in all details. No unsightly nail marks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.03.02 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.03.03 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.03.04 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.03.05 Drawers

Shall operate smoothly and have backstops to prevent them from being pushed too far. Locks shall engage securely.

3.03.06 Loose Furniture

When placed on a level surface, tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.00.00 IS CODES

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 848	-	Synthetic resin adhesives for plywood (Phenolic and Aminoplastic)
IS: 1003	-	Timber panelled and glazed shutters.
IS: 2191	-	Wooden flush door shutter (Cellular and hollow core type).
IS: 2202	-	Wooden flush door shutters (solid core type).
IS: 4021	-	Timber door, window, and ventilator frames.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall include of all activities mentioned in “Schedule of Item” for completion of the work. No separate payment shall be made for fixing, caulking, application of primer coat, polishing, providing of butt hinges,

holdfasts, sliding/tower bolts, door stoppers, door closers and other fittings and fixtures.

5.02.00 Measurement

Measurement shall be done in Sqm for doors, windows, ventilators, shutters, partitions etc.

Measurement for wooden frame shall be in CuM.

Pelmets shall be measured in RM.

VOLUME – II B
CIVIL, STRUCTURAL & ARCHITECTURAL WORKS

SPECIFICATION NO. PE-TS-999-600-C002

SECTION – D

SUB SECTION – D2

GENERAL TECHNICAL SPECIFICATION

CEMENT CONCRETE (PLAIN & REINFORCED)

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

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SUB-SECTION – D2

CEMENT CONCRETE (PLAIN & REINFORCED)

1.00.00 SCOPE

1.01.00 General

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Special requirements for structures such as reinforced concrete chimney, cooling towers, etc. have been covered under the respective specifications. Those specifications shall be used in conjunction with this specification.

1.02.00 IS: 456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate Code, specifications and/or replacement by any International code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference. However, should the list be not exhaustive and does not cover any aspect of the work, then relevant Indian and, in its absence, relevant International code shall apply.

2.00.00 General

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following

a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work.

b) Prepare Bar bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc.

c) Prepare working drawings of formworks, scaffolds, supports, etc.

d) Prepare shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedments, hangers, openings, frames etc.

e) Prepare detailed drawings of supports, templates, hangers, etc. required for

installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

As decided by the Engineer some or all of the drawings & schedules prepared under item (b) to (e) above will have to be submitted for approval.

f) Submit for approval detailed schemes of all operations required for executing the work, e.g. material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

g) Design and submit for approval concrete mix designs required to be adopted on the job.

Furnish samples and submit for approval results of tests of various properties of the following:

i) The various ingredients of concrete

ii) Concrete

iii) Embedments

iv) Joint seals

i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved Performa for satisfactory performance for a reasonable period as may be specified, binding both the manufacturers and the Contractor, jointly and severally.

2.02.00 Work by others

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Information to be submitted by the Tenderer

2.03.01 With Tender

The following technical information's are required with the tender:

a) Source and arrangement of processing of aggregates proposed to be adopted.

b) Type of plant and equipment proposed to be used.

c) Names of firms with which association is sought for to execute the special items of work in the contract.

d) Types of formwork proposed to be used.

2.03.02 After Award

The Contractor shall submit the following information and data including samples where necessary, progressively during the execution of the contract.

a) Programme of Execution

Within 30 days of the award of contract, the Contractor will submit a Master Programme for completion of the work.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day-to-day Programme of every month is to be submitted by the Contractor before the end of the previous month.

b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities free of cost, for approval. The Engineer for future reference will preserve approved samples. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

i) Coarse and fine aggregates.

ii) Admixtures.

iii) Plywood for Formwork.

iv) Embedded and anchorage materials as may be desired by the Engineer.

v) Joint sealing strips and other*waterproofing materials.

vi) Joint filling compounds.

vii) Foundation quality Rubber Pads.

c) Design Mix

Design mix as per specification giving proportions of the ingredients, sources of aggregates and cement, along with test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

d) Bar Bending Schedules

Bar Sending Schedules in accordance with Clause 2.01.00 (b) and 3.16.01 of this specification.

e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.01.00 (c).

f) Detailed Drawings for Templates & Temporary Supports for embedment As per Clause 2.01.00 (e).

g) Mill Test Reports for Cement & Reinforcing Steel.

h) Inspection Reports

The Engineer in accordance with Clause 2.04.00 of this specification may desire inspection Reports in respect of Formwork and Reinforcement and any other item of work as.

i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification or as directed by the Engineer.

j) Any other data, which may be required as per this specification or as directed by the Engineer.

2.04.00 Conformity with Design

The Contractor will prepare checklists in approved Performa, which will be called "Pour Cards". These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the engineer will give written permission on the same Pour

Cards allowing the contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the Engineer.

2.05.00 Materials to be used

2.05.01 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless-stated otherwise and be of best approved quality.

2.05.02 Cement

Ordinary Portland cement of grade-43 as per IS:8112/fly ash based Portland puzzolona cement conforming to IS:1489 (Part-1) shall preferably be used in reinforced/plain cement concrete works for all areas other than for the critical structures identified below. However, other types of cement such as ordinary Portland cement conforming to IS:269, Portland slag cement conforming to IS:455 respectively can be used under special circumstances. Cement used in all concrete mixes shall be in general of grade 33/43 unless design requires a higher grade. Ordinary Portland cement shall be used for following structure.

a) TG foundation top deck and sub structures including raft.

b) Spring Supporting decks of all machine foundations.

c) Structures requiring grade of concrete of M30 and above.

In special cases, Rapid Hardening Portland Cement, Low Heat Cement, Sulphate resistant cement, high strength Ordinary Portland Cement etc. may be permitted or directed to be used by the Engineer.
For Brickwork, plaster, flooring and other finishing works, ordinary Portland cement of 33/43 grade shall be used.

2.05.03 Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as

Coarse Aggregate. Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity, and free from deleterious materials. It shall be properly graded. Coarse aggregates shall be either crushed gravel or stone. All aggregates shall meet the requirement of IS:383:1970. Only Coarse Aggregate from, approved quarries and conforming to IS-383 will be allowed to be used on the works. Petrographic test shall be carried out by the contractor free of cost for checking the quality of rock from quarry. This test shall be repeated by the Contractor free of cost for change in quarry or as directed by the Engineer. The results shall be checked for reactivity of silica in aggregate with alkalis of cement.

2.05.04 Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS: 383 are termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used in works. Sand shall be hard, durable, clean and free from adherent coatings or organic matter and clay balls or pellets. Sand when used as fine aggregate in concrete shall conform to IS:383. For plaster, it shall conform to IS:1542 and for masonry work to IS:2116.

2.05.05 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts, or other impurities. Generally, IS: 3550 will be followed for routine tests. Acceptance of water shall be as per IS: 456.

2.05.06 Admixture

Only admixtures of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures, which may be necessary to satisfy the concrete mix and the design requirement, shall be as per IS-9103 and may be one of the followings:

a) Accelerating admixture

b) Retarding admixture

c) Water reducing admixture

d) Air entraining admixture

e) Water proofing admixture

The contractor shall inform the Engineer about the type of admixture which he is planning to use in different areas within the scope of work for the approval

of the Engineer. The admixture shall be of proven make and from a reputed manufacturer. It should not have any adverse effect on strength, durability of concrete and reinforcement. Super plasticizers conforming to IS: 9103 or ASTMC-494 shall only be used as admixture having the above properties either individually or in a combination as per the direction of the Engineer.

2.05.07 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract/Drawing/Instructions. All bars shall be of tested quality.

2.06.00 Storage of Materials

2.06.01 General

All materials shall be stored so as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and the cost incurred thereof shall be realised from the Contractor's dues. The Contractor shall maintain upto-date accounts of receipt, issue and balance (stack wise) of all materials. Storage of materials shall conform to IS: 4082.

2.06.02 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated warehouses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

2.06.03 Aggregates

Aggregates shall be stored on raised surface constructed by providing planks or steel plates or on concrete or brick masonry pavement. Each size shall be kept separated with wooden or steel or concrete or masonry bulkheads or in separate stacks and sufficient care shall be taken to prevent the material at the

edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.06.04 Reinforcement

Reinforcing steel shall be stored consignment-wise and size-wise off the ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease, and distortions.

If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust at no extra cost to the Owner. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.07.00 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same. The quality control operation shall include but not be limited to the following items of work:

a) Admixture:	Type, quantity, physical, and chemical properties that affects strength, workability, and durability of concrete. For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits.
b) Aggregate:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
c) Water:	Impurities tests.
d) Cement:	Tests to satisfy relevant IS Specifications.
e) Formwork:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.
f) Reinforcement:	Shapes, dimensions, length of splices, clearances, ties and supports. Quality and requirement of welded splices.

Material tests or Certificates to satisfy relevant IS Specification.

g) Grades of Concrete: Usage and mix design, testing of all properties.

h) Batching & Mixing: Types and capacity of plant, concrete mixers and transportation equipment.

i) Joints: Locations of joints, water stops and filler materials. Dimension of joints, quality, and shape of joint material and splices.

j) Embedded and Anchorage Items: Material, shape, location, setting.

k) Placing: Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.

l) Compaction: Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.

m) Setting of base & Bearing plates: Lines, elevations, and bedding mortar.

n) Concrete Finishes: Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.

o) Curing: Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.00.00 INSTALLATION

All installation requirements shall be in accordance with IS: 456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not

cover all the aspects to the full satisfaction of the Engineer.

3.01.00 Washing and Screening of Aggregates

Washing and screening of coarse and fine aggregates to remove fines, dirt, or other deleterious materials shall be carried out by approved means as desired by the Engineer.

3.02.00 Admixture

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete. Admixtures including plasticisers of approved make may be used with the Engineer's approval in accordance with IS-456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or owner satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.03.00 Grades of Concrete

Concrete shall be in one of the grades designated in IS: 456. Grade of concrete to be used in different parts of work shall be as shown on the drawing. In case of liquid retaining structures, IS: 3370 will be followed. Minimum cement content shall be as per IS: 456.

3.04.00 Proportioning and Works Control

3.04.01 General

"Design Mix Concrete" and "Nominal Mix Design" is defined as follows for use in this specification:

a) Proportioning of ingredients of concrete made with preliminary tests by designing the concrete mix. Such concrete shall be called "Design Mix Concrete".

b) Proportioning of ingredients of concrete made without preliminary tests adopting nominal concrete mix. Such concrete shall be called "Nominal Mix Concrete".

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades M-15 or lower only may be used if shown on drawings or approved by the Engineer. In all cases the Proportioning of ingredients and works control shall be in accordance with IS: 456 and shall be

adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.04.02 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability, and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations

a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

d) The finished concrete should have adequate durability in all condition, to withstand satisfactorily the weather and other destruction agencies, which it is expected to be subjected to in actual service.

e) The mix design shall have required workability and characteristic strength as per IS: 456. The quantity of cement, aggregates, and admixtures shall be determined by mass.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete in structural design. The Contractor will strictly abide by the same in his design of concrete mix installation. Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

3.05.00 Strength Requirements

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland Blast furnace slag cement is used, shall be as per IS:456. All other relevant clauses of IS:456 shall also apply.

3.06.00 Minimum Cement Content

The minimum cement content for each grade of concrete shall be as per IS: 456. Contractor has to consider actual environmental exposure condition at

site. Based on various tests results and as per Engineer, the environment condition shall be adopted for which minimum cement content shall be considered. No extra payment shall be made on account of any variation in environment condition.

a) Sufficient number of trial mixes (to be decided by the Engineer) will be taken at the laboratory for the various designs and graphs of w/c ratio Vs crushing strengths at various ages will be plotted.

b) All tests will be done in presence of the Engineer who shall be the final authority to decide upon the adoption of any revised minimum cement content. The Contractor will always be responsible to produce quality concrete of the required grade as per the acceptance criteria of IS: 456.

c) The Engineer will always have the unquestionable right to revise the minimum cement content as decided above, if, in his opinion, there is any chance of deterioration of quality on account of use of lower cement content or any other reason.

3.07.00 Water-Cement Ratio

The choice of water-cement ratio in designing a concrete mix will depend on:-

a) The requirement of strength.

b) The requirement of durability.

3.07.01 Strength Requirement

In case of "Design Mix Concrete" the water-cement ratio of such value as to give acceptable test results as per IS: 456, will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, the maximum water-cement ratio for different grades of concrete is specified in Table-5 of IS: 456 and no tests are necessary. The acceptance test criterion for nominal mix concrete shall be as per IS: 456.

3.07.02 Durability Requirement

Tables 4 & 5 of IS: 456 give the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by Durability consideration is lower than that required from strength criteria, the former should be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. Trial mix shall be carried out accordingly. However, the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer.

3.08.00 Workability

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments and to give the required surface finish shall depend*on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE-V

LIMITS OF CONSISTENCY

Degree of	Slump in mm with Standard Cone as	Use for which concrete is suitable

workability	per IS: 1199		
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipments, roads
Low	25	50	Uncongested wide and shallow R.C.C. structures
Medium	50	100	Deep but wide R.C.C. structures with congestion of reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. structures with congestion due to reinforcement and inserts.

Note: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

The workability of concrete shall be checked at frequent intervals by slump tests.

3.09.00 Size of coarse Aggregates

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer

Very narrow space	- 12 mm
Reinforced concrete Except foundation	- 20 mm
Ordinary Plain concrete and Reinforced concrete foundations	- 40 mm
Mass concrete	- 80 mm

Lean concrete - 40 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles

80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.09.01 Temperature control of concrete in top decks of machine foundations (i.e. of TGs, BFPs, Fans and Mills) as extra payable over RCC item of BOQ:

The temperature of fresh concrete shall not exceed 23°C when placed. A suitable measuring device for measuring the temperature of concrete as approved by the Engineer shall be used. For maintaining the limiting temperature of the 23°C, crushed ice shall be used as mixing water. The ice shall be formed of water conforming IS: 456. The Contractor shall establish the quantity of crushed ice to be mixed in order to achieve the limiting temperature of 23°C.

3.09.02 Base raft of Turbo Generator foundations and top decks of all machine foundations shall be cast in a continuous operation without any construction joint.

3.10.00 Mixing of Concrete

Ingredients of the concrete mix shall be measured by weight. Concrete shall always be mixed in mechanical mixer. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent Aggregates are used or when the mix is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement at no extra cost to the Owner to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Batching Plant shall conform to IS: 4925. The measuring gauges of batching plant shall be periodically calibrated for which the contractor shall provide standard weights. The accuracy of all gauges shall be within limits prescribed by the Engineer.

When hand mixing is permitted by the Engineer, for unimportant out of the way locations in small quantities, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch at no extra cost to the owner.

3.11.00 Conveying Concrete

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in-spite of all precautions, segregations does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers, which will reduce the rate of loss of water, by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before, commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12.00 Placing and Compacting Concrete

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in relevant I.S. code for any particular aspect of work, any other standard code of practice, as may be specified by the Engineer, will be

adopted. Concrete may have to be placed against the following types of surfaces:

a) Earth foundation

b) Rock foundation

c) Formwork

d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. Earth foundation on which direct placement of concrete is allowed, will be consolidated as directed by the Engineer such that it does not crumble and get mixed up with the concrete during or after placement, before it has sufficiently set and hardened.

Formwork, reinforcement, preparation of surface, embedments, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed or cement slurry will be spread thoroughly on the rock Foundation or construction joint just prior to placement of concrete.

After concrete has been placed, it shall be spread, if necessary & thoroughly compacted by approved mechanical vibration to maximum, subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas. Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of

Practice: In thin members with heavy congestion of reinforcement or other embedments, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement, and formwork are not displaced or distorted during placing & consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green Concrete, which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

Slabs, beams, and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Mouldings, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings, or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor at his own expense as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and reconstruct or repair the same -at the Contractor's expense.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13.00 Construction Joints and Cold Joints

3.13.01 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete certain predetermined stages. These joints will be formed in a manner specified in the drawings/Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12.

Where the location of the joints are not specified, it will be in accordance with the following:

a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

b) Concrete in a beam shall preferably be placed without a joint, but if Provision of a joint is unavoidable, the joint shall be vertical and at the middle of the span.

c) A joint in a suspended floor slab shall be vertical and at the middle of the span and at right angles to the principal reinforcement.

d) Feather-edges in concrete shall be avoided while forming a joint.

e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.02 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

a) If the concrete is so green that it can be removed manually and if vibrators

can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 *mm* in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not raise inspite of extensive vibration, the joint, will be left to harden for at least 12 - 24 hrs. It Will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14.00 Repairs, Finishes, and Treatment of Concrete surfaces

3.14.01 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, appropriate methods of handling, placing, and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete at the Contractor's cost. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods at no extra cost to the Owner, All concrete work shall be inspected by the Contractor immediately after the forms are removed & he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations:

a) Sack rubbing with mortar and stoning with carborundum stone.

b) Cutting away the defective concrete to the required depth shape.

c) Cleaning of reinforcement & embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.

d) Roughening by sand blasting or chipping.

e) Installing additional reinforcement/welded mesh fabric.

f) Dry packing with stiff mortar.

g) Plastering, guniting, shotcreting etc.

h) Placing and compacting concrete in the void left by cutting out defective concrete.

i) Grouting with cement sand slurry of 1:1 mix.

j) Repairing with a suitable mortar either cement or resin modified mortars.

k) Polymer modified patching and adhesive repair& mortar for beams & columns.

3.14.02 Finishing unformed Surface

The contractor shall provide normal finishes in unformed surfaces which can be achieved by screeding, floating, trowelling etc. A few typical and common cases of treatment of concrete surface are cited below

a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforced concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done, as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes, ripples, and trowel marks.

A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

b) Beans, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy, and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15.00 Protection and Curing of concrete

Newly placed concrete shall be protected by approved means from rain, sun, and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days, or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive 'Loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, hessian, canvas, or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor. Quality of water for curing shall be as per IS: 456.

If permitted by the Engineer, liquid curing compound may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form a thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall be emulsified paraffin based and shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water from concrete surface. It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision at no extra cost.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case the Engineer notices any lapse on the part of the Contractor, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and recover the cost thereof from the Contractor, or deduct certain amount from contractor's payment for the part where inadequate curing was noticed entirely at the discretion of the Engineer.

3.16.00 Reinforcement

Mild steel round bars, TMT bars, Hot rolled deformed bars or cold twisted deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc, will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.01 Bar Bending Schedules

The Contractor shall prepare **optimized** Bar Bending Schedules showing clearly the arrangements proposed by the Contractor to match available stock of reinforcing steel, progressively, starting within one week of receipt of approval on corresponding design of RCC structure. As decided by the Engineer, some or all the detailed drawings and schedules will have to be submitted for approval. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the contract. The contractor for record and distribution shall submit six prints of the final drawings & schedules with one reproducible print.

3.16.02 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.03 Bending

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS: 2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding with the

final Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any cutting, bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Rebending can be done only if approved by the Engineer. Reinforcing bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

3.16.04 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire or by tack welding in case of Bar larger than 25 mm dia., as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.05 Welding / Coupler for Splicing

Lapping shall normally do splicing of reinforcement. For M.S. reinforcement bars, butt-welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS: 2751 and IS: 456. For High yield strength deformed bars, lap welding may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards as per IS: 9417. Welding of High yield strength deformed bar shall not be allowed.

Splicing of reinforcement using mechanical coupler may be done, if permitted by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian standards for "Reinforcement couplers for mechanical splices of bars in concrete" as per IS: 16172. Corrosion test in the coupler-bar connections exposed to marine or

severe environmental conditions to rule out any risk of galvanic corrosion will be done by the contractor at no extra cost. Proper fitting & fixing of mechanical coupler to rebar shall be ensured at site for each coupled joint as per inspection testing plan developed at site in consultation with manufacturer of coupler. If so required at site, coupler/ threading on rebar shall be such that two bars can be coupled by moving couplers not rebar (as being heavy reinforcement weight and L shaped, it is not feasible to rotate the rebar for fixing up the coupler) at no extra cost.

3.16.06 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for placing concrete shall be such that reinforcement in position does not have to bear extra load and get disturbed. The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by –volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17.00 Cold Weather Concreting

When conditions are such that the ambient temperature may be expected to be 5°C or below during the placing and curing period, the work shall conform to the requirement of IS: 456 and IS: 7861.

3.18.00 Hot Weather Concreting

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS: 7861 and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 38°C while placing. Positive temperature control by precooling, post cooling or any other method, if required, will have to be done by the contractor at no extra cost.

3.19.00 Concreting under water

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of IS: 456.

3.20.00 Form Work

3.20.01 General

If it is so desired by the Engineer, the contractor shall prepare, before commencement of actual work, designs and working drawings for formwork and centring and get them approved by the Engineer. The formwork shall conform to the shape, grade, lines, levels and dimensions as shown on the drawings.

Materials used for the formwork inclusive of the supports and centring shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centring shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rakers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight and horizontal pressure of the concrete as a liquid as well as the working load. In case the contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel and concrete of adequate strength shall be used. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion-resistant devices. Rigid care shall be exercised in ensuring that all column forms are in true plumb and thoroughly cross-braced to keep them so. All floor and beam centring shall be crowned

not less than 8 mm in all directions for every 5 metres span. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.02 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, sawdust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil or other compound before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.03 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns, and walls are independent of the soffits of beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork.

Removing any props or repropping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

3.20.04 Inspection of Forms

Casting of' Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.05 Removal of Forms

Formwork shall be kept in position after casting of concrete for a minimum period as mentioned in IS: 456, however the period of retaining form in position can be extended as per drawing, instruction of Engineer or as required for satisfactory completion of work without any extra cost. Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if the Engineer so desires.

The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly. The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him without any extra cost to the Owner, The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

If any other type of cement other than ordinary Portland cement and Rapid hardening cement is used, the time of removal of forms shall be revised such that the strength of this cement at the time of removal of forms match with strength of Portland cement at the time of removal of form.

3.20.06 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this specification or drawings or directed by the Engineer:-

For - a) Sectional dimension - ± 5 mm
b) Plumb - 1 in 1000 of height
c) Levels - ± 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in .the finished concrete surface & should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.07 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as specified hereinbefore. Formwork shall not be used/re-used if declared unfit or unserviceable by the Engineer.

3.20.08 Classification

Generally, the "ordinary" class formwork shall be used unless otherwise specified.

a) **Ordinary:** These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

b) **Plywood:** These shall be used in exposed surfaces, where specially good finish is required and shall be made of approved brand of heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilization of used plywood for the "ordinary" class, if it is still in good condition.

c) **Ornamental:** These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21.00 Opening, Chases, Grooves, Rebates, Blockouts etc.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22.00 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and other misc. Embedded Fixtures

The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as shown on drawings and secure the same as may be required. The materials shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to paint with one coat of approved anti- corrosive paint and/or bituminous paint without any extra cost to the Owner. If welding is to be done subsequently on the exposed surface of embedded material, the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be

required or directed by the Engineer.

Items to be embedded

a) Inserts, hangers, anchors, frame around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

b) Anchor bolts and plates for machinery, equipment and for structural steel work.

c) Steel structurals to be left embedded for future extension, special connection etc.

d) Dowel bars, etc. for concrete work falling under the scope of other contractors.

e) Lugs or plugs for door and window frames occurring in concrete work.

f) Flashing and jointing in concrete work.

g) Any misc. embedments and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23.00 Expansion and Isolation Joints

3.23.01 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension, and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.02 Bitumen Board/ Expanded Polystyrene Board

a) Bitumen Board

Bitumen impregnated fibreboard of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

b) Expanded Polystyrene Boards

If required, commercial quality of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.03 Joint sealing strips

Joint sealing strips may be provided at the construction, expansion, and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water or any other material into or out of the structure. The sealing strips will be either metallic like G.I., Aluminums, or Copper, or non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation -including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanized.

a) Metal Sealing Strips

Metal sealing strips shall be either G.I., Aluminium or Copper and formed straight, U shaped, Z shaped or any other shape and of thickness as indicated in the drawing. The transverse joints will be gas welded using brass rods and approved flux and will be tested by an approved method to

establish that it is leak proof. If required, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

i) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The standard of Galvanizing shall be as per relevant Indian Standards for heavy-duty work. At the joints, the overlapping should be for a minimum length of 50 mm.

ii) Aluminium Strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS: 737 of 19000 grades or 31000 grade (Designation as per IS: 6051). A minimum lap of 50 mm length is required at the joints.

iii) Copper Strips

The Copper strips shall be minimum 18 SWC in thickness and 300 mm width unless specified otherwise and shall conform to the relevant Indian Standards. It should be cleaned thoroughly before use to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

b) Non-metallic Sealing Strips

These will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features:

i) Plain

ii) Central bulb

iii) Dumb-bell or flattened ends

iv) Ribbed and Corrugated Wings

v) V shaped

As these types of seals can be easily handled in very large lengths unlike metal strips, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the

central bulbs & the edges accurately.

c) Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion, and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/Sq.mm
Maximum Safe Continuous Temperature	:	75°C
Ultimate Elongation	:	Not less than 350%

b) P.V.C., Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion, and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to SOA
Tensile Strength	:	10 - 15 N/Sq.mm
Maximum Safe Continuous Temperature	:	70 Deg.C
Ultimate Elongation	:	Not less than 275%

3.23.04 Bitumen Compound

When shown in drawing or directed, the gap in expansion joints shall be

thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

3.23.05 Isolation Joints

Strong and tough alkathene sheet or equivalent, about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.06 Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness - 65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24.00 Grouting under Machinery or Structural Steel Bases

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stone chips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If specified on drawings, admixtures like Aluminium powder, "Ironite" etc. may have to be added with the grout in required proportions. Premixed non-shrink grout of approved manufacture having proper strength shall be used with Engineer's approval for important machineries.

3.25.00 Precast Concrete

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose. This yard shall be dry, properly levelled and having a hard and even surface. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard,

lifting equipment, curing tank, finished material storage space etc. shall be designed such that the units are not lifted from the mould before 7 (seven) days of curing and can be removed for erection after 28 (twenty-eight) days of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal. The yard shall preferably be fenced.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling, and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials, and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as per drawings. If centrings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26.00 Waterproofing of Concrete Structure

3.26.01 General

Where required, waterproofing of concrete structures shall be ensured internally by suitable design of the concrete mix, addition of suitable admixtures in the concrete or mortar at the time of mixing and/or installing water bars at the joints. In addition to the above measures, the structures shall be made watertight by adopting "structural waterproofing" as per specification. The design, material, and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor free of charge. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.02 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be metallic, rubber, or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint shall be provided as per clause 3.13.1 with or without water bar/seal as shown

on the drawing. In case of water bars being used at the construction joint, fixing of the same has to be done carefully, so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods.

Method 1: A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting. In case of walls, the above bonding agent will be mixed with water, which will be used for making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two-component epoxy resin-bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days

Compressive strength	-	55 to 60 N/Sq.mm
Flexural strength	-	5 to 30 N/sq.mm
Tensile strength	-	15 N/Sq.mm (approx.)
Bonding strength to concrete	-	3 N/Sq.mm (approx.)
Bonding strength to steel	-	20 N/Sq.m (approx.)

The whole operation shall be done as per manufacturers specification. The contractor shall provide manufacturer's supervision at no extra cost to the owner.

Method 2: One row of threaded nozzles at regular intervals not exceeding l.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the concrete has set to seal the voids in concrete near the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 kg/sq.cm. The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision. The cost of such manufacturer's supervision shall be borne by the contractor.

3.26.03 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar/plaster shall conform to IS: 2645. The admixture shall not cause decrease of strength of concrete/plaster at any stage and it shall be free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5%. The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement, but a lower dosage will always be preferred. The product shall be stored in strong moisture proof packings. However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water reducing concrete admixture shall be used to provide a waterproof concrete, For achieving high strength concrete having cement content around 400 kg/cu.m. a melamine based super plasiticizer will be preferable.

a) In concrete: The admixtures shall be procured from reliable and reputed manufacturers and approved by the Engineer. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor at no extra cost to supervise the work, if desired by the Engineer.

b) In Plaster: The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor at no extra cost. On completion, the Plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.04 Structural waterproofing

a) Nozzles spaced as required after the concrete is completed shall be drilled into surfaces to be rendered watertight. Non-shrink cement grout with waterproofing compound as per manufacturers specifications shall be injected under pressure to seal all voids. Special care shall be taken at joints by providing additional nozzles. The pressure grouting shall be done on the internal surface.

b) External Treatment

Two layers of (1:4) plaster of 12 mm thick each with waterproofing compound as per manufacturer's specification shall be provided on outer

surface of concrete underground structures.

3.26.05 Protective coating on Inside Surface.

Two coats of cement based two components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.06 Bitumen Felt: Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt should be hessian base and/or fibre base as specified in Drawing. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor without charging any extra to the Owner.

The Contractor shall execute this work in direct collaboration with one of the well-known specialized firm approved by the Engineer.

Cleaning the surface, keeping it dry, providing, necessary corner fillets and cement rendering and cutting chases, etc. shall be done as per drawings and/or instructions. If any protective brickwork on/against concrete sub-bases or walls are required, the same shall be provided. A twenty (20) years guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.07 Polyethylene Films: Application in Walls or base of structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder

i) the concrete surface shall be made smooth with 12 mm cement plaster 1:6.

ii) apply hot bitumen 80/100 grade (IS: 73-1961) at the rate of 1.0 Kg/Sq.m minimum

iii) lay black polyethylene film 250-micron (IS: 2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having

three parallel sealing bars. A long piece of plywood is to be placed below the polyethylene film to be heat-sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a cellophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another cellophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat-sealing, the cellophane tape is to be removed and the joints are to be tested for leaks.

iv) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen,

v) Lay hot bitumen 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.

vi) Lay 250-micron polyethylene film as second layer similar to (iii)above.

viii) Lay second layer of 100 gm. brown craft paper laminated similar to (iv) above.

ix) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

x) Protecting with a layer of 75 mm plain cement concrete M-10, or a layer of brick laid in cement mortar 1:6 in case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortar as shown on the drawing.

3.27.00 Protective Coating on Concrete Surface

3.27.01 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing by using rubber/bitumen emulsion protective coating of approved manufacturer.

4.00.00 SAMPLING AND TESTING

4.01.00 General

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the teat results in triplicate within 3 (three) days after completion of the test.

4.02.00 Cement

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths as per guidelines of IS: 269. Soundness Tests may also be required to be carried out if required by the Engineer. The Contractor shall carry out the tests without any expense to BHEL. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the BHEL or the Contractor. These tests are of great importance, as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.03.00 Aggregates

The contractor shall carry out any or all the tests on aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.04.00 Water

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The acceptance criteria will be as per IS: 456.

4.05.00 Admixture

4.05.01 Air Entraining Agents

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cylinder cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After that, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.05.02 Other Admixtures

Tests for establishing the various properties of any other admixtures, which may be required to be added, shall be carried out by the Contractor.

4.06.00 Concrete

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199, the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516. Sampling procedure, frequency of sampling and test specimen shall conform to IS: 456. To control the consistency of concrete from every mixing plant, slump tests shall be carried out by the Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference. The acceptance criteria of concrete shall be in accordance with IS: 456. Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor at his own cost. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

5.00.00 ACCEPTANCE CRITERIA

5.01.00 Standard Deviation

Standard deviation shall be based on test results and determination of Standard deviation shall conform to IS: 456.

5.02.00 Acceptance Criteria

The strength requirements and acceptance criteria shall conform to IS: 456.

5.03.00 Inspection and Core Tests

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to IS: 456.

5.04.00 Load Test

Load tests of structural members as per IS:456 may be required by the Engineer, when the strength of test specimen results falls below the required strength.
If the member shows evident failure, the Contractor shall make the structure adequately strong free of cost to BHEL.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification. The entire cost of dismantling and replacement and restoration of the site being borne by the Contractor.

If, in the course of dismantling, any damage is done to the embedded items

and or other adjacent structures, the same will be made good, free of charge by the Contractor to the satisfaction of the Engineer.

6.00.00 RATES AND MEASUREMENTS

6.01.00 Cast-in-situ Concrete

6.01.01 Rates

a) The unit rates shall include the cost of labour, materials, equipment, handling, transporting, botching, mixing, placing in position, vibrating, compacting, finishing, curing, testing, etc. at all elevations. This shall include the cost of curing by regular wetting or by using curing compound.

b) The unit rates shall include for all working conditions including at locations under water, liquid, mud, in or under foul positions and extreme weather conditions.

c) The unit rates for exposed concrete works (including machine foundations) shall include all incidentals, rendering, smoothening with carborandum stone, finishing with a paste of cement sand mortar, curing, etc.

d) The unit rates shall include all arrangement for maintaining stability of structure during execution.

e) Nothing extra shall be payable for the handling/mixing of extra cement on account of any reason or pouring of second stage concrete.

f) Nothing shall be payable to the Contractor on account of facilities and arrangement provided by him for conducting ultrasonic pulse velocity (UPV) tests or other relevant tests to ascertain grade and quality, etc. of the concrete in case the concrete quality is in doubt and contractor has to establish the quality by further tests. In case of any defects, the Contractor shall rectify the same by cement/epoxy grout at his own cost.

However, mandatory UPV test as specified in the drawings shall be carried out including arrangement of all its facilities, staging, etc. and shall be payable to the contractor as per BOQ item.

g) The unit rates for controlling of the temperature of concrete shall include storing and mixing of ice, water, cooling of aggregate etc.

h) The quoted rate shall include the cost of MIX design, making of all trial mixes using admixtures and mixing in concrete etc. complete.

6.01.02 Measurements

a) Actual volume of concrete work as executed or as per drawings issued, whichever is less shall be measured in cubic metres to the nearest two decimals.

b) No deductions shall be made for the following:

i) Ends of dissimilar materials embedded inside for example, beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sqcm in cross section;

ii) Opening upto 0.1 sq.m.

iii) Volume occupied by reinforcement, sleeves, anchor bolts, and similar items.

iv) Volume occupied by pipes, conduits, sheathing, etc. not exceeding 100 sq.cm. each in cross sectional area.

c) The concrete works of different grades; below and above ground floor finished level shall be measured separately, unless otherwise specified in the schedule of items. Accordingly rates shall be applied for concrete in foundation for concrete below ground floor finished level and concrete in superstructure for concrete above ground floor finished level.

d) For temperature control measures, measurement shall be done in terms of quantity of concrete in cum. in concreting of which the ice have been used or cooling of aggregates has been done to keep the temperature of freshly laid concrete to less than 23^0C.

6.02.00 Reinforcement

6.02.01 Rates

a) The unit rates shall include for cover block, providing binding wire, welding, separator pieces between two or more layers of reinforcement required for keeping the steel in position, etc. at all elevations.

b) No extra will be paid for transportation from stores, cleaning, straightening of steel, cutting, bending, binding with annealed wire, welding, tack welding, placing the reinforcement modification of already embedded reinforcement, if required, due to faulty fabrication or placement and other cost of tools and plants, materials, labours, return of unused steel to the store, etc. If reinforcement steel issued is by BHEL to the contractor for use in reinforcement steel work, the unit rate shall include stacking of cut pieces/ scrap steel generated out of reinforcement steel work as per size (dia) for easy retrieval for further use.

c) However, lap welding of reinforcement steel if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made. Similarly, splicing of reinforcement bars using mechanical couplers if permitted shall be paid under separate item as provided in the BOQ and no deduction for labour and binding wire saved for not providing lap length shall be made.

d) No extra shall be paid for preparing and getting approved bar bending schedules (including all revisions).

e) Generally members are straight and have straight edges. However, for bending, binding, placing of reinforcement in any curved member in length or cross section or both, no extra payment shall be made.

6.02.02 Measurements

a) Bar or any other type of reinforcement used like hard drawn steel wire fabric etc. for reinforced concrete shall be measured by weight in tonnes. The weight shall be arrived at by multiplying the actual or theoretical length measured alongwith standard hooks, cranks, bends, authorized laps, etc. whichever is less by the sectional weights. Claims for payment for this item shall be submitted with supporting documents giving the schedule of bars with sketches. The sectional weight to be adopted shall be IS Section weight. Nothing extra will be payable to the Contractor on account of, difference in weight, if any, due to different methods adopted for issue and measurement.

b) Standard hooks, cranks, bends, authorised laps, supports, hangers and chairs which are covered in approved bar bending schedule shall be measured in tonnes.

6.03.00 Formwork and Staging

6.03.01 Rates

a) The unit rates shall be inclusive of all staging, scaffolding, making the formwork watertight, etc. for all elevations and in all types of works.

b) No separate payment shall be made for providing fillets, for rounding or chamfering at junctions, comers, etc.

c) The unit rates shall include the cost of labour, materials etc. and the extra time, which shall be required for the removal of shuttering/ support for satisfactory completion of work.

d) No extra payment shall be made on account of difficulty, wastage etc. for placement/removal of formwork between the network of closely placed steel beams or for the lacing/bracing portions and ribbed slab constructions.

e) Payment for curved shuttering shall be made for curved members/wall whose centerline radius in plan is less than 6m.

f) If the contact surface area in pockets is less than or equal to 0.1 sq.m. in each case, payment shall be done under item for providing formwork in pockets.

6.03.02 Measurements

a) Formwork for different classes (types) shall be measured separately as the actual surface in contact with the concrete and paid on area basis unless included in the rate for concrete. The unit of measurement shall be in sq.m.

b) Openings upto 0.1 sq.m or boxing left for inserts etc. for facility of Contractor's work, shall be neglected as if nonexistent for the purpose of formwork measurement of surface in which the openings occur.

For suspended floor, no deduction shall be made for flange area of secondary steel beams.

d) No measurement shall be taken for the formwork in pockets, openings, chases, blockouts, etc. in concrete, the contact surface area is less than or equal to 0.1 sq.m. in each case.

e) For pockets, if the contact surface area is less than or equal to 0.1 sq.m. in each case, measurement shall be done under item for providing formwork in pockets.

e) Formwork, if required, for joints shown on drawing or instructed by the Engineer, shall be paid for the 'leading side' only.

6.04.00 Embedded Parts

6.04.01 Rates

a) The unit rate for erection of embedded steel parts, supplied by Engineer shall include transportation from Owner's store to the place of work, erection & installation including setting material in concrete, etc. complete.

b) The unit rate for MS pipe embedments and PVC pipe embedments shall include cutting, welding, fabrication, erection, embedding, and transportation to site. Unit rate shall also include the cost of the pipes.

c) Rate for expansion fasteners shall include cost of fasteners, installation, and fixing including cost of washers and nuts and site testing if required.

6.04.02 Measurements

a) The measurement of the embedded steel parts fabricated and installed by the Contractor shall be based on the calculated weight of steel sections in tonne corrected to second place of decimal.

b) Embedded steel parts supplied by Owner and installed by Contractor Measurement shall be done for the net weight of the embedments installed in tonnes correct to second place of decimal.

c) For PVC pipes/conduits, measurements shall be in quintals correct to second place of decimal for the net weight.

d) For mild steel pipes, measurement shall be in quintals, correct to second place of decimal, for the net weight of the steel pipe supplied, fabricated, and installed.

e) The lugs shall be measured in Kg. correct to second place decimal for the net weight.

f) The expansion fasteners shall be measured in number according to tension capacity.

g) The rails shall not be treated as embedded steel part and the track shall be measured in running metres along the centre line and paid for under separate item of work as specified in schedule of items. Other related civil items associated with the laying of track shall be measured separately and paid under respective items of works.

6.05.00 Groutings

6.05.01 Rates

Rate shall include the cost of surface preparation, admixtures, and curing.

6.05.02 Measurements:

a) Measurement shall be in cubic decimeters.

b) Measurement for grouting shall be by volume of the block out, pockets or bolt hole upto the top surface of foundation concrete and shall be calculated from the dimensions shown on the drawings.

c) Measurement for underpinning shall be by volume between the top surface of the foundation concrete and the underside of the base plate, the plan dimensions being as indicated on the drawings.

d) No deduction shall be made for shims, bolts, shear keys and such other embedments.

f) Pressure injection grouting with cement based grout if required as per drawing shall be applied at appropriate spacing to cover the desired surface area and measurement shall be made for the surface area grouted in sqm as per BOQ item. However in water retaining structures, the structural grouting if required to ensure water tightens shall not be payable separately as deemed to be covered in water retaining concrete item of BOQ.

6.06.00 Joints

6.06.01 Rates

The unit rate shall include all the activities described in the schedule of items.

6.06.02 Measurements

a) Bitumen Board/Expanded polystyrene.

The measurement for bitumen board shall be based on actual finished surface area in square meters nearest to second decimal, for the specified thickness.

b) Water Stops

The measurement for water stops shall be in running metres of actual length of the joint covered, for specified thickness, width, and shapes. No separate measurement shall be made for laps/splices for cross-joints and mitered joints.

c) Metal Cover Strips

The measurement for Metal Cover Strips shall be based on actual finished surface area in square metres for the specified thickness.

d) Vibration Damping Resilient Pads

The measurement for this item shall be in square metres for the specified thickness, measured correct to the second place of decimal, of the actual finished surface area.

6.07.00 Dismantling/Demolishing Work – RCC and PCC and Chipping of Concrete

6.07.01 Rates

The unit rates shall include the cost of all necessary propping, shoring, underpinning scaffolding, safety measures, temporary enclosures, disposal/ stacking of serviceable/unserviceable materials, etc. for all types of work and for all grades of concrete.

In the case of dismantling/demolishing work, the cutting of reinforcement shall also be included in the rate.

In the case of chipping work, the cutting of reinforcement shall be paid separately.

If the serviceable material including reinforcement steel from dismantled structure is allowed to be used/taken out by bidder, suitable rebate shall be given by bidder.

6.07.02 Measurements

a) Dismantling of PCC and RCC work shall be measured in cu.m separately. Measurement of all work, except hidden work shall be taken before execution of work and no allowance for increase in bulk shall be allowed. Specifications for deductions of voids, openings etc, shall be done on the same basis as that applied for construction work.

b) Chipping of concrete, making holes/pockets etc. shall be measured in cubic decimeters (i.e. 0.001 cu.m.).

c) Cutting of reinforcement in chipping work for making of pockets and openings shall be measured in sq. cm. of cross-sectional area.

6.08.00 Precast Concrete

This clause shall be read in conjunction with relevant provisions specified elsewhere for cast in-situ Concrete.

6.08.01 Rates

a) The unit rate shall include cost of preparation of casting yard, formwork, concrete and its casting, finishing as specified, setting filling of gaps between adjacent pre-cast concrete units with concrete, or cement mortar, curing, handling, erection, grouting, welding, preparation of supporting surface, etc.

6.08.02 Measurements

The measurement of pre-cast concrete members shall be on the basis of volume of concrete in cubic metres nearest to second place of decimal. No deduction shall be made for volume occupied by reinforcement/inserts/sleeves and for openings up to 0.1 sq.m. The setting of element with cement mortar shall not be measured separately The filling of concrete cement mortar between the gaps of adjacent precast units shall be considered while computing the volume of pre-cast concrete work and shall be paid for under this item itself.

7.00.00 LIST OF IS CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed:-

IS: 73 - Indian Standard Specification for Paving Bitumen

IS: 216 - Indian Standard Specification for Coal Tar Pitch

IS: 383 - Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete

IS: 432 - Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement

IS: 455 - Indian Standard Specification for Slag Cement

IS: 456 - Indian Standard Code of Practice for Plain and Reinforced Concrete

IS: 457 - Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive

Structures

IS: 516 - Indian Standard Specification for Methods of Test for Strength of Concrete

IS: 702 - Indian Standard specification for industrial bitumen.

IS: 1199 - Indian Standard Specification for Methods of Sampling and Analysis of Concrete

IS: 1322 - Indian Standard Specification for Bitumen Felts for Waterproofing and Damp-proofing

IS: 1489 - Indian Standard Specification for Portland Pozzolona Cement

IS: 1566 - Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.

IS: 1609 - Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

IS: 1786 - Indian Standard Specification for High Strength Deformed Steel Bars and Wires for Concrete Reinforcement.

IS: 1791 - Indian Standard Specification for Batch Type Concrete Mixers.

IS: 1838 - Indian Standard Specification for preformed fillers for expansion joints in concrete pavements and structures (non-extruding and resilient type.

IS: 2185 - Indian Standard Specification for Hollow Cement Concrete Blocks

IS: 2210 - Indian Standard Specification for Design of Reinforced Concrete shell Structures and Folded Plates

IS: 2386 - Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII

IS: 2502 - Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement

IS: 2505 - Indian Standard Specification for Concrete Vibrators, Immersion Type

IS: 2506 - Indian Standard Specification for Screed Board Concrete Vibrators

IS: 2514 - Indian Standard Specification for Concrete Vibrating Tables

IS: 2571 - Code of practice for laying in-situ cement concrete floors.

IS: 2645 - Integral cement water proofing compound

IS: 2722 - Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)

IS: 2750 - Indian Standard Specification for steel scaffoldings.

IS: 2751 - Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction

IS: 2770 - Indian Standard Specification for Method of Testing Bond in Reinforced Concrete

IS: 3025 - Indian Standard specification for Methods of Sampling and Test (Physical and Chemical) for Water used in Industry

IS: 3067 - Code of practice for general design details and preparatory work for damp proofing and water proofing of building.

IS: 3201 - Indian Standard Specification for Design and Construction of Precast Concrete Trusses

IS: 3370 - Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids

IS: 3414 - Code of practice for design and installation of joints in buildings.

IS: 3550 - Indian Standard Specification for Method of Test for Routine Control for Water used in Industry

IS: 3558 - Code of Practice for use of Immersion vibrators for Consolidating Concrete

IS: 3696 - Safety Code for Scaffolding and Ladders

IS: 3812 - Indian Standard Specification for Fly Ash for Use as Admixture for Concrete

IS: 4014 - Code of practice for steel tubular scaffolding.

IS: 4031 - Indian Standard Specification for Method of Tests for

Hydraulic Cement

IS: 4082 - Indian Standard Specification for Recommendation on Stacking and Storage of Construction Materials at site

IS: 4090 - Indian Standard Specification for Design of Reinforced Concrete Arches

IS: 4634 - Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixes

IS: 4656 - Indian Standard Specification for Form Vibrators for Concrete

IS: 4925 - Indian Standard Specification for Concrete Batching and Mixing Plant

IS: 4926 - Indian Standard Specification for Ready Mixed Concrete

IS: 4990 - Indian Standard Specification for Plywood for Concrete Shuttering work

IS: 4991 - Indian Standard Specification for Blast Resistant Design of structure for Explosion above ground

IS: 4995 - Indian Standard Specification for Design of Reinforced Part-I & II Reinforced Concrete Bins for the Storage of Granular and Powdery Materials

IS: 4998 - Indian Standard Specification for Design of Reinforced Concrete Chimneys.

IS: 5256 - Code of practice for sealing joints in concrete lining on canals.

IS: 5512 - Indian Standard Specification for Flow Table for use in Tests of Cement and Pozzolanic materials

IS: 5513 - Indian Standard Specification for vacate Apparatus.

IS: 5515 - Indian Standard Specification for Compaction Factor Apparatus.

IS: 5525 - Recommendation for detailing of reinforcement in reinforced concrete works.

IS: 5624 - Indian Standard Specification for foundation bolts.

IS: 5751 - Indian Standard Specification for Precast Concrete Coping

Blocks.

IS: 5816 - Indian Standard Specification for Method of Test for Splitting Tensile strength of Concrete Cylinders.

IS: 5891 - Indian Standard Specification for Hand operated Concrete Mixers.

IS: 5892 - Indian Standard Specification for transit mixer and agitators.

IS: 6452 - Indian Standard Specification for High Alumina Cement for Structural Use

IS: 6909 - Indian Standard Specification for Super sulphated Cement

IS: 6923 - Indian Standard Specification for Method of Test for Performance of Screed Board Concrete Vibrators.

IS: 6925 - Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures.

IS: 7242 - Indian Standard Specification for Concrete Spreaders.

IS: 7246 - Indian Standard Specification for Table Vibrators for Consolidating Concrete.

IS: 7251 - Indian Standard Specification for Concrete Finishers.

IS: 7293 - Safety code for working with construction machinery.

IS: 7320 - Indian Standard Specification for Concrete Slump Test Apparatus.

IS: 7861 - Indian Standard Specification for Recommended Practice Part-I&II for Extreme Weather Concreting.

IS: 7969 - Safety Code for Storage and Handling of Building Materials.

IS: 8041 - Indian Standard Specification for Rapid Hardening Portland cement.

IS: 8112 - Indian Standard Specification for high strength Ordinary Portland Cement.

IS: 8142 - Indian Standard Specification for Determining Setting time of concrete by Penetration Resistance.

IS: 8989 - Safety Code for Erection of Concrete Framed Structures.

IS: 9012 - Recommended method for shortcreting.

IS: 9013 - Indian Standard Specification for Method of Making, Curing, and determining compressive Strength of Accelerated-cured Concrete Test Specimens.

IS: 9077 - Code of Practice for Corrosion Protection of Steel Reinforcement in RB and RCC Construction.

IS: 9103 - Indian Standard Specification for Admixtures for Concrete.

IS: 10262 - Recommended Guidelines for Concrete Mix Design.

IS: 13311 - Non-destructive testing of concrete.

SP: 34 - Handbook of concrete, reinforcement and detailing.

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SECTION - D
(PART I)

SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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SUB-SECTION – D 18

ERECTION OF STRUCTURAL STEELWORK

1.00.00 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at site, installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:

a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour, and supervision required for erection of the structural steelwork.

b) Receiving, unloading, checking, and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharfage charges etc. on account of default on his part.

c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, riveting, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be rectified with Engineer's approval. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

e) Aligning, plumbing, leveling, riveting, bolting, welding and securely fixing the fabricated steel structures including floor gratings, chequered plates etc. in accordance with the Drawings or as directed by the Engineer.

f) Painting of the erected steel structures.

g) All minor modifications of the fabricated steel structures as directed by the

Engineer including but not limited to the following:

i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

ii) Cutting, chipping, filling, grinding, etc. if required for preparation and finishing of site connections.

iii) Reaming of holes for use of higher size rivet or bolt if required.

iv) Refabrication of parts damaged beyond repair during transport and handling or refabrication of parts, which are incorrectly fabricated.

v) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

vi) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

vii) Carry out tests in accordance with this specification.

2.02.00 Work by Others

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.03.00 Codes and Standards

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:

IS: 800 - Code of practice for general construction in steel.

IS: 456 - Code of practice for main or reinforced concrete.

2.04.00 Conformity with Designs

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the sequence and the design criteria laid down by the Engineer. All work shall conform to the provisions of this specification and /or instructions of the engineer. The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specifications and/or the instructions o the Engineer.

2.05.00 Material

2.05.01 General

All fabricated steel structures and connection materials shall be supplied by the Contractor to the site. The Contractor shall take delivery from railway wagons or trucks at site, and unload the materials and perform all formalities like checking of materials and attend to insurance matters in accordance with Sub-Clause 2.01.00 and as specified hereinbefore.

2.05.02 Materials to conform to Indian standards

All materials required to be supplied by the Contractor under this contract shall conform to the relevant Indian Standard specifications.

2.06.00 Storage of Materials

2.06.01 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the engineer shall be at liberty to get the materials removed by agency and the cost incurred thereof shall be realised from the Contractor's dues.

2.06.02 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other raw steel materials such as structural sections and plates as required. The yard shall have facilities like drainage, lighting, and suitable access for large cranes, trailers, and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved Programme of work.

The Tenderer must visit the site prior to submission of his tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor at his own cost as directed by the Engineer.

2.06.03 Covered Store

All field connection materials, paints, cement etc. shall be stored on well

designed racks and platforms off the ground in a properly covered store building to be built at the cost of the Contractor.

2.07.00 Quality Control

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the Following items of work :

i) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

ii) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency, and strength of grout.

iii) Painting: Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

2.08.00 Taking Delivery

The Contractor shall take delivery of fabricated structural steel and necessary connection materials from railhead/trucks as may be necessary and as directed by the Engineer. He shall check, unload; transport the materials to his stores for proper storing at his own cost. The Contractor shall submit claims to insurance or other authorities and pursue the same in case of loss or damage during transit and handling and all loss thereof shall be borne by him.

The Contractor shall also take all precautions against damage of the materials in his custody after taking delivery and till the same are erected in place and accepted. The Contractor shall salvage, collect, and deliver all the packing materials to the Owner free of charge.

3.00.00 WORKMANSHIP

3.01.00 Erection

3.01.01 Plant and Equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be thoroughly verified. They shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.01.02 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Contractor shall arrange for most economical method and sequence available to him consistent with the drawings and specifications and other relevant stipulations of the contract.

3.01.03 Temporary Bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erecrtion shall install, free of cost to the Owne, temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made free of cost to the Owner.

The requirement of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned, and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

The temporary guys, braces, false work, and cribbing shall not be the property of the Owner and they may be removed immediately upon completion of the steel erection.

3.01.04 Temporary Floors for Buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or bylaws of state, Municipal or other local authorities.

3.01.05 Setting Out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance with the approved Drawings and to the satisfaction of the Engineer. For heavy columns, etc. the Contractor shall set proper screed bars to maintain proper level. No extra payment shall be made for this.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance under this Specification.
No permanent field connections by riveting, bolting or shall be carried out until proper alignment and plumbing has been attained.

3.01.06 Field Riveting

All rivets shall be heated and driven with pneumatic tools. Hand passing or "throwing" of rivets are desirable. Any other method of conveying hot rivets from the furnace to the driving point must be approved by the engineer. No-cold rivets shall be driven. All other requirements of riveting including quality and acceptance criteria shall be in accordance with the relevant portions of the Specification for Fabrication of Structural Steelwork of the Project.

3.01.07 Field Bolting

All relevant Portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other, defects that would prevent solid seating of the parts. Contact surfaces within friction type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

a) Turn-of-nut Method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the Joint are brought into good contact with each other. 'Snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-I with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation

there shall be no rotation of the part not turned by the wrench.

TABLE-I

Bolts length not exceeding 8 times dia or 200 mm	Bolt length exceeding 8 times dia or 200 mm	Remarks
1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. Tolerance on rotation-30° over or under.

Bolts may be installed without hardened washers when tightening is done by the turn -of-nut -method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

b) Torque Wrench Tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE-II (See Note below the Table). Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE-II

Nominal Bolt Diameter (mm) of IS:1367	Torque to be applied (Kg.M) for bolt class 8.8
20	59.94
22	81.63
24	103.73

Note: The above torque values are approximate for providing tensions of 14.

7 T for 20 mm dia.; and 21.2 T for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. These torques shall be applied for tightening the bolts on that day with the particular wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds. Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.01.08 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.01.09 Holes, Cutting and Fitting

No cutting of sections, flanges, webs, cleats, rivets, bolts, welds etc. shall be done unless specifically approved and /or instructed by the Engineer.

The erector shall not cut, drill, or otherwise alter the work of other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is obtain specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work. The Contractor shall not be entitled for any payment on account of any such work.

3.02.00 Drifting

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member

or makes it impossible to fill the holes properly or to adjust accurately after reaming, shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.03.00 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand grout mix, if required, by the Engineer or shown on the drawings.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled, and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

If required by the Engineer, certain admixtures like aluminium powder, “ironite” or equivalent, may be required to be added to the grout to enhance certain desirable properties of the grout. Approved non-shrink pre-mixed grout having required flowability and compressive strength may also be used with Engineer's approval.

3.04.00 Painting after Erection

Field painting shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. Normally, final painting shall be done only after the floor slabs are concreted and masonry walls are built. However, touch up painting, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the Contractor free of cost to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural

steelwork applicable for the project.

Painting shall not be done in frosty or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field rivets, bolts, welds, and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces, which will be in contact after site assembling, shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface, which will be inaccessible after field assembly shall receive the full, specified protective treatment before Bolts and fabricated steel members who are galvanized or otherwise treated and steel members to be encased shall not be painted.

The final painting shall be of tow coats of Synthetics Enamel painting or Aluminium paint of approved manufacture as per the approved "Schedule of Painting". The shades shall also be as per the approved schedule. Synthetic enamel paint shall conform to IS: 2932.

3.05.00 Final cleaning up

Upon completion of erection and before final acceptance of the work by the Engineer, the contractor shall remove free of cost all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

4.00.00 TESTING AND ACCEPTANCE CRITERIA

4.01.00 General

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member as per the Contract and no payment towards the cost of the dismantled portion and any connected work shall be made to the contractor. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good free of cost by the Contractor, to the satisfaction of the Engineer. The Cost of the tests specified hereinafter shall be borne by the Owner; but if the structure fails to pass the tests, the cost of the tests shall be recovered from the Contractor. Any extra claim due to loss of time, idle labour, etc. arising out of these testing operations shall not be entertained, however, only reasonable and appropriate time extensions will be allowed.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following sub-clauses 4.01.01, 4.01.02 and 4.01.03. The method of testing and application of loading shall be as approved by the Engineer.

4.01.01 Stiffness Test

In this test, the structure or member shall be subjected, addition to its actual dead load, to a test load equal to 1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 per cent of the maximum increase in strain or deflection recorded during the second test.

4.01.02 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on the removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.01.03 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 time the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.01.04 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use, shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.01.01 hereinbefore.

4.02.00 Tolerances

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steel work applicable to this Project and as specified below: The specified tolerance is mainly for welded erection. In case of bolted erection, no tolerance is desired so that all prefabricated bolt holes are matched on erection.

I. For Buildings Containing Cranes

Component	Description	Variation Allowed
1.	2.	3.
Main columns	a) shifting of column axis at foundation level with respect to building line	
	i) In longitudinal direction	i) ± 3.0 mm
	ii) In lateral direction	ii) ± 3.0 mm
	b) Deviation of both major column axis from vertical between foundation and	

	other member connection levels:	
	i) For a column upto and including 10M height	i) ± 3.5 mm from true vertical
	ii) For a column greater than 10M but less than 40M height	ii) ± 3.5 mm from true vertical for any 10 M length measured between connection levels, but not more than ±7 mm per 30m length.
	c) For adjacent pairs of columns across the width of the building prior to placing of truss	± 9.0 mm on true span.
	d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	± 3.0 mm
	e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating	3.0 mm
Trusses	a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or greater than 10mm whichever is the least.
Trusses	b) Lateral displacement of top chord at center of span from vertical plane running through center of supports.	1/250 of depth of truss or 20 mm which ever is the - least.
Crane Cirders	a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm.
	b) Deviation to crane rail-gauge	± 3.0 mm

	c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermite welding.	1.0 mm.
	d) Deviation of crane rail axis from centre line of web.	± 3.5 mm
Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30°C. The coefficient of expansion or contraction shall be taken as 0.000012 per °C per unit length.	

iv) For Building without Cranes

The maximum tolerances for line and level of the steel work shall be ±3.0 mm on any part of the structure. The structure shall not be Out of Plumb more than 3.5 mm on each lox section of height and not more than 7.0 mm per 30 m section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.03.00 Acceptance

Structures and members have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.01.00, 4.01.01, 4.01.02, 4.01.03 and 4.01.04 and other applicable provisions of this specification and are within the limits of tolerances specified in Sub-clause 4.02.00 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfillment of the provisions of this contract.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 Before Tender

5.01.01 Tentative Programme

The Tenderer shall submit a tentative programme based on the information available in the Tender Document and visit to site indicating the structure-wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.01.02 Constructional Plant and Equipment, Tools, Temporary works & manpower A detailed list Of all constructional plant and equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be indicated.

5.01.03 Erection Yard

A site plan showing the layout and location of the erection yard proposed to be established by the tenderer shall also be attached with the tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.02.00 After award of the Contract

After award of the contract, the Contractor shall submit the following:

5.02.01 Detailed Programme

The Contractor shall submit a detailed erection programme within a month of the award of the Contract for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required, and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.02.02 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.02.01 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

VOLUME: II B

SECTION - D

SUB-SECTION – D1

EARTHWORK IN EXCAVATION AND BACKFILLING

SPECIFICATION NO. PE-TS-999-600-C001

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.0	SCOPE	3
2.00.00	GENERAL	3
3.00.00	EXECUTION	6
4.00.00	TESTING AND ACCEPTANCE CRITERIA	19
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STANDARD TECHNICAL SPECIFICATION FOR EARTHWORK IN EXCAVATION AND BACKFILLING

1.0.0 SCOPE

This specification covers earth work excavation in all types of soil, soft rock and hard rock including setting out, clearing and grubbing, shoring, dewatering, back filling around foundations/pipelines to grade, watering, compaction of fills, testing, approaches, disposal of surplus earth, protective fencing, lighting etc relevant to the structures and locations covered under this contract.

2.0.0 GENERAL

2.1.0 Work to be provided for by the Contractor

The work to be provided for by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision services, earth moving machineries, surveying instruments including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

b) Preparation and submission of working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering including drainage, space for temporary stacking of soils, disposal area, fencing etc and all other details as may be required by the engineer.

c) To carry tests and submit to the Engineer, test results of fill materials and degree of soil compaction of fill whenever required by the Engineer to assess the quality of fill.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc. including procurement of necessary licenses from proper authorities.

2.2.0 Work to be provided by others

No work under this specification will be provided by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.3.0 Codes and Standards

All works shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes unless specified otherwise.

IS-1200	Method of measurement of building and civil engineering works, Part-I: Earthwork
IS-2720	Method of test for soils (Relevant parts)
IS-3764	Excavation work - Code of safety
IS-4081	Safety code for blasting and related drilling operations
IS-4701	Indian Standard Code of Practice for earthwork on Canals
IS:6922	Criteria for safety and design of structures subject to underground blasts
IS: 3764	Excavation work – code of safety

In case of conflict between this specification and those (IS Codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by this specification/IS Codes, any other standard practice as may be specified by the engineer shall be followed.

2.4.0 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

2.5.0 Materials

2.5.1 General

All materials required for the work shall be of the best commercial variety and approved by the engineer.

2.5.2 Material for Excavation

For the purpose of identifying the various strata encountered during the course of excavation, refer clause no. 3.4.0 for the classification of earth strata.

2.5.3 Material for Filling

Material to be used for back filling shall be free from vegetations, roots, salts, rubbish, lumps, organic matter and any other harmful chemicals etc and shall be got approved by the engineer. Normally excavated earth shall be used for back filling. In case such earth contains deleterious salts, the same shall not be used. All clods of earth shall be broken or removed. Where the excavated material is mostly rock and if filling with the same is permitted by the engineer in writing, then the filling with rock shall be done in the following

manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling.

In case the earth required for backfilling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. The selected earth from the borrow areas shall be got approved by the engineer. The borrowed material shall be free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods etc. The contractor shall obtain and submit necessary clearances/permissions from the concerned authorities for the borrow areas/materials acquired to the engineer.

If specified, the back filling shall be done with clean well graded sand from approved quarries free from harmful and deleterious materials.

2.6.0 Quality Control

All works shall confirm to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Back filling	(a) On quality of fill material (b) On moisture content of back fill (c) On degree of compaction achieved

2.7.0 Information regarding site conditions

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as a guidance only and variation therefrom shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and / or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction

likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0.0 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and back filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of slopes, shoring, approaches, dewatering, drainage, berms etc. for the approval of engineer.

3.1.0 Setting out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the same shall be rectified by the contractor at his own risk and cost.

3.2.0 Initial Levels

Initial levels of the ground either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. All records of levels, measurements etc. and also any drawing, cross-section etc. made therefrom, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3.0 Clearing and Grubbing

The area to be excavated shall be cleared out of fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Trees upto 300mm girth shall be uprooted. Trees above 300mm girth to be cut shall be approved by the engineer and marked. Cutting of trees shall include removing roots as well. After the tree is cut and roots taken out, the pot holes formed shall be filled with good earth in 250mm layers and compacted unless directed otherwise by the engineer. The trees shall be cut in to suitable pieces as instructed by the

engineer. Before earthwork is started, all the spoils, unserviceable materials and rubbish shall be burnt or removed and disposed to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timber, fire woods etc shall be the property of the owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

3.4.0 Classification

All earthwork shall be classified under the following categories:

No distinction will be made whether the material is dry or wet.

a) **Ordinary Soil**

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

b) **Hard Soil**

This shall include :
i) stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied ;
ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm ;
iii) soling of roads, paths, etc., and hard core ;
iv) macadam surfaces such as water bound, and bitumen/tar bound;
v) lime concrete, stone masonry in lime mortar and brick work in lime/cement mortar, below ground level ;
vi) soft conglomerate, where the stones may be detached from the matrix with picks ; and
vii) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

c) **Soft and Decomposed Rock**

This shall include :
i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars ;
ii) unreinforced cement concrete which may be broken up with crowbars or picks and stone masonry in cement mortar below ground level ;
iii) boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded

in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and
iv) any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

d) **Hard Rock (requiring blasting)**

This shall include :
i) any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;
ii) reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and
iii) boulders requiring blasting.

e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.5.0 Excavation for Foundations and Trenches

3.5.1 General

All excavation shall be done to the minimum dimensions as required for the safety and working facility. In each individual case, the contractor shall obtain prior approval of the engineer for the method he proposes to adopt for the excavation including dimensions, side slopes, shoring, dewatering, drainage and disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. All excavation in open cuts shall be made true to the line, slopes and grades as shown on the drawings and/or as directed by the engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders (if any) projecting out of the excavated surfaces shall be removed if they are likely to be a hindrance to the work/workers in the opinion of the engineer.

Method of excavation shall in every case be subject to the approval of the engineer. The contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works etc including the safety of the workmen. If any slip occurs, the contractor shall remove all the slipped materials from the excavated pit without any extra cost to the engineer/owner. All loose boulders and semi detached rocks which are not inside but so close to the area to be excavated and may liable to fall or otherwise endanger the

workmen, equipment of the work etc during excavation in the opinion of the engineer shall be stripped off and removed away from the area of excavation. The method to be used for removal shall be such that it should not shatter or render unstable or unsafe the portion which was originally sound and safe. In case any material not required to be removed initially but later to become loose or unstable in the opinion of the engineer shall also be promptly and satisfactorily removed.

The rough excavation may be carried out upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the engineer. If the excavation (in all types of soil and rock) is done to a depth greater than that shown on the drawing or as directed by the engineer, the excess depth up to the required level shall be filled with cement concrete not leaner than 1:4:8 or richer as directed by the engineer at the own risk and cost of the contractor. In case where excavation in soil, soft rock (including weathered rock) and hard rock are involved, the excavation in each stratum shall be carried out separately with the approved methodology and as per the instructions of the engineer.

All excavated materials such as rock, boulders, bricks, dismantled concrete blocks etc shall be the property of the owner and shall be stacked separately as directed by the engineer. All gold, silver, oil, minerals, archeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the owner and the contractor shall duly preserve the same to the satisfaction of the engineer/owner. The contractor shall deliver the same to such person or persons as may be authorized or appointed from time to time by the owner to receive the same.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.

3.5.2 Excavation in All Type of Soil and in Soft Rock

The excavation in all type of soil, soft rock including decomposed rock etc shall be carried out as per the approved proposal and as directed by the engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. Foundation pits shall not be excavated to the full depth unless construction is imminent. The last 150mm depth shall be excavated once concreting work is imminent. At the discretion of the engineer, the full depth may be excavated and the bed be covered with lean concrete as specified after watering and compacting the bed. As the excavation reaches the required dimensions, lines, levels and grades

etc, the work shall be got checked and approved by the engineer. In cases where deterioration of the ground, upheaval, slips etc are expected, the engineer may order to suspend the work at any stage and instruct the contractor to carry out the protection works before the excavation will be restarted.

3.5.3 Excavation in Hard Rock

Hard rocks shall normally be excavated by means of blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is not stable against sliding, necessary supports such as props, bracings or bulkheads shall be provided and maintained during the period of construction. Where the danger of falling loose rock/boulder from the excavated surfaces deeper than 2m exist, steel mesh anchored to the lower edge of the excavation and extending over and above the rock face adequate to retain the dislodged material shall be provided and maintained.

3.5.4 Blasting

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

3.5.4.1 Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

3.5.4.2 Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine.

Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be

provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

3.5.4.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his

responsibilities.

Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

3.5.4.5 Restrictions in Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

3.5.5 Disposal

The excavated spoils shall be disposed of in any (or all) of the following manner as directed by the engineer.

a) By using it straightway for backfilling.

b) By stacking it temporarily to use for backfilling at a later date during execution of the contract.

c) i) By either spreading
or
ii) By spreading and compacting at designated disposal areas.

a) By selecting the useful material and stacking it neatly in designated areas as indicated by the engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus Materials

All surplus material from excavation shall be removed and disposed of from the excavation site to the designated disposal area indicated by the engineer.

All good and sound rocks obtained from excavations and all assorted materials of dismantled structures are the property of the owner and if the contractor wants to use it, he shall have to obtain it from the engineer at a mutually agreed rate. All sound rocks and other assorted materials like excavated bricks etc shall be stacked separately.

3.5.7 Protection

The contractor shall notify the engineer as soon as the excavation is expected to be completed within a day so that he shall inspect it at the earliest. Immediately after approval of the engineer, the excavation must be covered up in a shortest possible time. But in no case the excavation shall be covered up or worked on before approval by the engineer. Excavated material shall be placed 1.5m or half the depth (of excavation) whichever is more from the edge of the excavation or further away if directed by the engineer. Excavation shall not be carried out below the foundation level of the structure close by until the required precautions are taken. Adequate fencing is to be made enclosing the excavation. The contractor shall protect all the underground services exposed during excavation. All existing surface drains in the work area shall be suitably diverted by the contractor before taking up excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably praticable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted , redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.5.9 Dewatering

All excavation shall be kept free of water and slush. Grading in the vicinity shall be controlled to prevent the surface water running into the excavations. The contractor shall remove any water inclusive of rain water and subsoil water etc accumulated in the excavation by pumping or other means as approved by the engineer and keep the excavations dewatered and/or lower the subsoil water level to 300mm below the founding level until the construction of foundation and backfilling are completed in all respects.

Sumps made for dewatering must be kept clear of the foundations. The engineer's prior approval on the method of pumping to be adopted shall be

taken; but in any case, the pumping arrangement shall be such that there shall be no movement or blowing in of subsoil due to the differential head of water during pumping.

3.5.10 Timber Shoring

Close or open type timber shoring as approved by the engineer depending on the nature of sub-soil, depth of pit or trench and the type of timbering shall be adopted. Timbers made out of approved quality shall only be used. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called "polling boards". These shall be of 250mm wide(min.) and 40mm thick(min.) sections as directed by the engineer. The boards shall generally be placed vertically in pairs, one on each side of the cut and shall be kept apart (maximum spacing is limited to 1.20m) by horizontal walers of strong wood cross strutted with wooden struts or as directed by the engineer. The length of wooden struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of excavation and supported by vertical walers which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed to avoid any slipping out of earth.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started from one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.5.10.2 Open Timbering

In case of open timbering, vertical board of 250mm wide(min.) and 40mm thick(min.) shall be spaced sufficiently apart to leave unsupported strips of maximum 500mm average width. The detailed arrangement, size of timber and the spacing etc shall be subjected to the approval of the engineer. In all other respects, the specification for close timbering shall apply to open timbering as well.

3.6.0 Treatment of Slips

The contractor shall take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides of the excavations. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips still occur, the same shall be removed by the contractor with his own risk and cost.

3.7.0 Backfilling

3.7.1 General

The material to be used for backfilling shall be approved by the engineer which shall be obtained directly from the excavation, from the nearby areas where excavation work by the same agency is in progress, from the temporary stacks of excavated spoils or from the borrow pits as directed by the engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials etc.

In locations where sand filling is required, the sand used should be clean, well graded and be of the quality normally acceptable for use in concrete.

3.7.2 Filling and Compaction in Pits and Trenches all Around the Structures

As soon as the work in foundation has been accepted, the spaces around the foundation in pits and trenches shall be cleared of all debris, brick bats, mortar droppings etc and filled with approved earth in layers not exceeding 250mm (in loose thickness). Each layer(loose) shall be watered, rammed and properly compacted to the required degree to the satisfaction of the engineer. Earth shall be compacted with approved mechanized compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the engineer. The moisture content of the fill material during compaction shall be controlled near to its optimum moisture content so as to obtain the required degree of compaction. The final surface shall be trimmed and levelled to proper profile as desired by the engineer.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250mm (in loose thickness) and each layer shall be watered and compacted to the required degree with approved compaction machine or manually if specifically permitted by the engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted in order to avoid any settlement at a later stage. The finished surface of fill shall be trimmed to the slope intended to be provided for the floor.

3.7.4 Filling in Trenches for Water Pipes and Drains

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150mm, watered, rammed and compacted taking care that no damage is caused to the pipe below.

In case of trenches excavated in rock, the filling upto a height of 300mm or the diameter of the pipe whichever is more above the crown of the pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash as per the availability at site and shall be filled in compacted layers not exceeding 150mm. The remaining filling shall be done in layers with the mixture of boulders (of size not exceeding 150mm) and fine material as specified elsewhere in the specification. Each layer shall be watered, rammed and compacted to the required degree and to the satisfaction of the engineer.

3.7.5 Filling in Disposal Area

Surplus materials from excavation which are not required for backfilling shall be disposed of in the designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250mm thick when loose, watered and compacted with the help of a compacting equipment as per the directions of the engineer. In wide areas, rollers shall be employed and compaction shall be done to the satisfaction of the engineer at the optimum moisture content which shall be checked and controlled by the contractor. In certain cases the engineer may direct the contractor to dispose the surplus materials without compaction which can be done by tipping the spoils from a high bench neatly maintaining a proper level and grade of the bench.

3.8.0 Approaches and Fencing

The contractor should provide and maintain proper approaches for the workmen and inspection. The roads and approaches around the excavation should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as around the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.9.0 Lighting

Full scale area lighting is to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.0.0 TESTING AND ACCEPTANCE CRITERIA

4.1.0 Excavation

On completion of excavation, the dimension of the pits will be checked as per the drawings after the pits are completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations are filled back to the required lines, levels and grades by placing ordinary cement concrete of 1:4:8 proportion and/or richer and/or by compacted earth as directed by the engineer. The choice of the grade of concrete will be a matter of unfettered discretion of the engineer. Over excavation of the sides shall be made good by the contractor while carrying out the backfilling. The excavation work will be accepted after the above requirements are fulfilled and all the temporary approaches encroaching inside the excavation have been removed.

4.2.0 Backfilling

The degree of compaction required will be as per the stipulation laid down in IS: 4701 and the actual method of measuring the degree of compaction will be as decided by the engineer. The work of back filling will be accepted after the engineer is satisfied with the degree of compaction achieved.

5.0.0 RATES AND MEASUREMENTS

5.1.0 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding section in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

f) In case blasting in hard rock is envisaged, the unit rate quoted for earth work shall include the cost of storage and safety arrangements for the materials required for blasting. No separate payment will be made on this account.

5.2.0 Measurements

Method of measurements are specified as below:

a) The length, breadth and depth shall be measured correct to the nearest centimeter if measurements are taken by tape. Rounding of numerical shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter respectively correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in excavation shall be computed from these levels in cubic meter.

c) In case of open footings (rafts/ pilecaps/ drains/ cable trench/ pipe trench/ sub soil beams etc.) up to the depth of 2.0 metres from ground level, alround excavation of 30 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional/excess excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for item of work on excavation, backfilling, carriage, dewatering etc. Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in the quoted rates in the schedule of quantities.

d) In case of open footings (Rafts/ pilecaps / drains/ cable trench/ pipe trench/ sub soil beams etc.) at a depth of more than 2.0 metre from ground level, alround excavation of 75 cm beyond the outer dimension of footing (not the PCC dimension below footing) shall be measured for payment to make allowances for centering and shuttering. Any additional/excess excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment for item of work on excavation, backfilling, carriage, dewatering etc. Required shoring & strutting, side slopes, benching, dewatering sump pits, approaches to the excavated pit etc. are deemed to be included in the quoted rates in the schedule of quantities.

e) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a

deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation, then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

f) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rock so arrived shall be taken as soil.

g) The authorized quantity (calculated on the basis of authorized width/ working space under clause no. 5.2.0 c & 5.2.0 d) or those actually excavated, whichever, are less, shall be measured for payment.

h) Tree cutting having girth more than 300mm shall be measured in number and are separately payable as deemed not covered in excavation items of work in the schedule of quantities.

6.0.0 INFORMATION TO BE SUBMITTED BY THE BIDDER

6.1.0 With Tender

Detail of equipments and machineries proposed to be used for excavation, backfilling and compaction shall be submitted along with the tender.

6.2.0 After Award

After award of the contract the successful bidder shall submit the following for approval.

a) Within 30 days of the award of contract, the contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation for the various foundations and the time required for backfilling and compaction after completion of foundation for the structures. The earthwork programme shall be planned in accordance with the foundation programme. The programme should also show how the excavation and backfilling quantities will be balanced minimizing the temporary stacking of

spoils. It is to be noted that the engineer even after initial approval of the programme may instruct the contractor to enhance or to retard the progress of work during the actual execution in order to match with the progress of foundations. The initial programme being submitted by the contractor should have sufficient flexibility to take care of such reasonable variations.

b) Within 15 days of the award of contract, the contractor shall submit the drawings for earth work in excavation and backfilling showing detail of slopes, shoring, approaches, sump pits, dewatering lines, fencing etc for the approval of the engineer.

VOLUME: II B

SECTION - D

SUB-SECTION – D10

FINISH TO MASONRY AND CONCRETE

SPECIFICATION NO. PE-TS-999-600-C010

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	SCOPE	3
2.00.00	INSTALLATION	3
3.00.00	ACCEPTANCE CRITERIA	8
4.00.00	I.S. CODE	8
5.00.0	RATES AND MEASUREMENTS	9

FINISH TO MASONRY AND CONCRETE

1.00.00 SCOPE

This Section covers finishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment.

Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimize damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.00.01 INSTALLATION

2.01.00 Preparation of Surface

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be rushed down with stiff wire brush to remove all loose dust from joints and thoroughly, washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval of the Engineer shall be taken as to the acceptability of the base.

2.02.00 PLASTERING

2.02.01 Mortar

Mortar for plastering shall be as specified.
For sand cement plaster, sand and cement in the specified proportion shall be mixed dry, on a watertight platform and minimum water added to achieve

working consistency. The sand for plaster shall conform to IS: 1542.

No plaster, which has stood for more than half an hour, shall be used; plaster that shows tendency to become dry before this time shall have water added to it.

2.02.02 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat; the overall thickness of the coats shall not be less than the minimum thickness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The undercoat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall, without any extra cost to the Owner, make up any irregularity in the brickwork with plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.02.03 Finish

Generally, the standard finish shall be used unless otherwise Shown on drawing or directed by the engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the engineer regarding the texture, color and finish.

a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough; otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. per Sq.M. and rubbed smooth with a trowel.

c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.02.02 but using Coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the topcoat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest editions.

Samples of colouring material shall be submitted to the engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.02.02. While the mortar is still plastic small pebbles or crushed stone of size generally from 10mm to 20mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of oil a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

e) Rough-cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

f) Scraped Finish

Ordinary plaster as described under Clause 2.02.02 after being leveled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the

Engineer.

g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause 2.2.2 Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer.

h) Sand Faced Plaster

The plaster shall be applied in 2 coats. The first coat or the scratch coat should be approximately 14mm and shall be continuously carried out without break to the full length of wall or natural breaking points such as doors, windows, etc. The scratch coat shall be dashed on the prepared surface with heavy pressure, brought to true and even surface and then lightly roughened by cross scratch lines, to provide bond for the finishing coat. The mortar proportion for this scratch coat shall be as specified in the respective item or work. The scratch coat shall be cured for at least 7 days & then allowed to dry. The second coat shall be 6mm thick and it shall not be applied until at least 10 days have elapsed after the application of scratch coat. Before application of the second coat, the scratch coat shall be evenly damped. This coat shall be applied from top to bottom in one operation & without joints; finish shall be straight, true, & even. The mortar of this coat shall be as specified under the respective item of work. White sand for finish shall be used for the second coat & for finishing work. Sand for finish shall be of even coarse size & shall be dashed on the surface & sponged.

2.02.04 Curing

All plastered surfaces after laying shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.03.00 Pointing to masonry

All Joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finishes with suitably tools to shape as shown on

the drawings. Any surplus mortar shall be scalped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.04.00 Plaster with Metal Lath

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two-layers. The mortar for plastering shall consist of 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.02.01. The application, finish etc. shall be as specified under relevant clause above. Where called for a 2 mm Plaster of Paris punting shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.05.00 Lime Punning

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punting shall be applied by skilled workman and given a smooth and ever finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.06.00 Plaster of Paris Punning

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq.M. areas and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.07.00 Stone Facing

Stone facing where specified shall be done as shown on design drawings and

approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawings for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings. They shall be fastened to wall with suitable non-corrodible anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanized (weight of zinc coating shall. not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and 3 parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer.

The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.00.00 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply with the Specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as mentioned in the body of the specification or as shown on drawings.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 1661: Code practice for cement and cement-lime plaster finish on wall & ceilings.

IS: 4101: code of practice for external facings and veneers.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall also include providing, dismantling and removing of scaffolding, surface preparation, curing and all type of surface, shapes/ profiles and at all elevations.

5.02.00 Measurement

All plastering shall be measured net (on surface area on which it is applied) in Sqm. Plaster work shall be classified according to the type used and shall be measured separately. Plaster on ceiling and walls shall be measured separately. Soffits of stairs shall measured as plastering on ceiling.

No deduction shall be made for opening not exceeding 0.5 Sqm and for ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sills of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

VOLUME: II B

SECTION - D

SUB-SECTION – D22

SITE LEVELLING & GRADING WORKS

SPECIFICATION NO. PE-TS-999-600-C022

Maharatna Company

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
1.00.00	GENERAL	3
2.00.00	SCOPE	3
3.00.00	MATERIALS	4
4.00.00	QUALITY CONTROL	6
5.00.00	EXECUTION	6
6.00.00	RATES AND MEASUREMENTS	15

GENERAL TECHNICAL SPECIFICATION FOR SITE LEVELLING AND GRADING

1.00 GENERAL

This specification cover the works to be carried out for **"Site Levelling and Grading Works including Slope Protection"** etc for the entire plant and associated areas. The specified formation level(s) shall be achieved either by excavation or by raising with controlled fill with excavated/borrowed earth as the case may be.

2.00 SCOPE

2.01 The scope include all works involved in levelling the site to the lines, grades, cross sections and dimensions as shown on the approved drawings and/or as directed by the engineer including site clearance, setting out, earth work in excavation, stacking, loading, transportation, unloading, dewatering, drainage, filling, watering, compaction, turfing on slopes (if required), lighting, disposal of residual/surplus earth etc. It also include supplying and providing all labour, materials, supervision, services, equipments, tools and plants, testing and all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work etc.

2.02 All tools and plants, equipments and machineries to be used in this work shall be of standard quality and manufactured by reputed concerns conforming to Indian Standard (IS) codes or equivalent thereof.

2.03 Work to be provided by the Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Supplying and providing all labour, supervision, services including as required under statutory labour regulations, materials, equipments, tools and plants, approaches, transportation etc required for the completion of the work.

b) Preparation and submission of detailed scheme of all operations required for executing the work (material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out sampling and testing on fill materials/fills to assess the quality/moisture content/degree of compaction and submission of the test results whenever required by the engineer.

d) Design, construction and maintenance of Magazine of proper capacity for storage of explosives for blasting work and removal of the same after completion of the work etc.

2.04 Work to be provided by others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

2.05 Codes and Standards

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) codes unless specified otherwise.

IS: 1200 Methods of measurement of building and civil engineering works, Part-1: Earthwork

IS: 2720 Method of test for soils (Relevant parts)

IS: 3764 Excavation work- Code of safety

IS: 4081 Safety code for blasting and related drilling operations

IS: 4701 Code of practice for earthwork on canals

IS: 6922 Criteria for safety and design of structures subject to underground Blasts

In case of conflict between this specification and those (IS codes) referred to herein, the former shall prevail. In case any particular aspect of work is not covered specifically by the specification or/and by the IS codes, any other standard practice as may be specified by the engineer shall be followed.

2.06 Conformity with Designs

The contractor shall carry out the work as per the approved drawings, specification and as directed by the engineer.

3.00 MATERIALS

All materials required for the work shall be of best variety and approved by the engineer.

3.01 Materials for Excavation

For the purpose of identifying the various strata met during the course of excavation, the following classification is to be followed.

a) Soil

It include all type of soil including laterite, moorum etc with/without any percentage of kankars which can be excavated by normal means such as shovel, pick axe, crow bar, spade etc and those which do not fall under **clause** 3.01 (b) and (c) etc.

b) Soft Rock

It include the rocks (including weathered rock) which are removable by splitting with the help of crow bar, pick axe, wedges, pavement breakers, pneumatic tools, hammers or such implements etc and not requiring blasting (for excavation) in the opinion of the engineer.

c) Hard Rock

It includes the rocks, which require blasting for excavation in the opinion of the engineer. Where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other method as approved by the engineer. The mere fact that the contractor resorts to blasting shall not classify the soft rock under hard rock.

However, the engineer's decision on the type of strata encountered during excavation shall be the final and binding on the contractor.

3.02 Materials for Filling

Any coarse grained or fine grained low plastic soil free from vegetation, roots, shingle, salts, organic matters, sod and any other harmful chemicals shall be used for filling. The contractor shall test the fill material to establish its suitability and submit the results to the engineer for approval. Fill material shall be got approved by the engineer. The following type of materials shall not be used for filling.

a)Materials from swamps, marshes and bogs
b)Expansive clays
c)Peat, logs, sod and perishable materials
d)Materials susceptible to combustion
e)Any material or industrial and domestic produce which will adversely affect other materials of work
f)Materials from prohibited areas

The earth available by cutting the high grounds within the project site and the materials (if) available from the road excavation or any other excavation under the same contract shall be used for filling depending upon its suitability as fill material. Filling with excavated rock (in the project site) shall be done only with

the written permission of the engineer in the following manner. The boulders shall be broken into pieces not exceeding 150mm size in any direction and mixed with fine materials consisting of decomposed rock, moorum or any approved earth to fill the voids as for as possible and the mixture shall then be used for filling. In case the earth required for filling is over and above the earth available from the compulsory excavations within the project area, then borrow areas for obtaining suitable fill material shall be arranged by the contractor himself from outside the plant boundary limits and all expenses including royalties, taxes, duties etc shall be borne by him. He shall obtain and submit the necessary clearances/permissions from the concerned authorities to the engineer for the borrow areas/materials acquired.

4.00 QUALITY CONTROL

All works shall conform to the lines, levels, grades, cross sections and dimensions shown on the approved drawings and/or as directed by the engineer. The contractor shall establish and maintain quality control for the various aspects of the work, method of construction, materials and equipments used etc. The quality control operation shall include but not be limited to the following.

Sl. No.	Activity	Check
1	Lines, levels & grades	a) By periodic surveys b) By establishing markers, boards etc
2	Filling	(a) On quality of fill material (b) On moisture content of fill material (c) On degree of compaction achieved

5.00 EXECUTION

The contractor shall prepare and submit the detailed drawings/schemes for excavation and filling works as proposed to be executed by him showing the dimensions as per the construction drawings and specification adding his proposal of approaches, dewatering (if any), drainage and compaction etc within 15 days of award of the contract to the engineer for approval.

5.01 Site Clearance

Before the commencement of earthwork, the entire area of cutting and filling shall be cleared of all trees, stumps, bushes, grasses, vegetation etc with their roots, fences, logs, rubbish, water, slush etc. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below the existing ground level or 300mm below the formation level whichever is deeper. After the removal of roots of trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The trees shall be cut in to suitable pieces as instructed by the engineer. Before earthwork is started, all the spoils, unserviceable materials and

rubbish shall be burnt or removed and disposed off to the approved disposal area(s) as specified by the engineer. Useful materials, saleable timbers, fire woods etc shall be the property of owner and shall be stacked properly at the worksite in a manner as directed by the engineer.

5.02 Setting Out

On receiving the approval from the engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the engineer and fix permanent points and markers for the ease of periodic checking as the work proceeds. These permanent points and markers shall be fixed at the interval as prescribed by the engineer and shall be got checked and certified by the engineer after whom the contractor shall proceed with the work. It should be noted that this checking by the engineer prior to the start of the work will in no way relieve the contractor of his responsibility of carrying out the work to true lines, levels and grades as per the drawings and specification. If any errors are noticed in the contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. The contractor shall take spot levels of the area (with respect to the bench mark/ available source as provided by the engineer) to be excavated or to be filled at an interval of not more than 10m or as directed by the engineer before starting any earth work and shall be submitted to the engineer for prior approval.

5.03 Excavation

Levelling by excavation shall be carried out where the existing ground levels are higher than the specified formation level. Excavation shall include removal of all materials whatever nature as may be and whether wet or dry shall be carried out exactly in accordance with the line, levels, grades and curves shown on the approved drawings and/or as directed by the engineer. All excavations shall be done to the minimum dimensions as required. The contractor shall obtain prior approval of the engineer for the method he proposes to adopt for excavation in different types of strata including dimensions, side slopes and dewatering if any, stacking or disposal etc. This approval however shall not in any way make the engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to any other activities in the area. **Prior to starting the excavation, the ground level at the location shall be checked jointly with the engineer.**
The rough excavation may be carried up to a maximum depth of 150mm above the final formation level. The balance shall be excavated with special care and the final surface shall be compacted by rolling with 6 passes of 8 to 10 tonne roller. If directed by the engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer. The contractor shall be paid for the extra excavation and filling at the appropriate items of work.

If the excavation is done to a depth greater than that shown on the drawing or as directed by the engineer due to the contractor's fault, the excess depth shall be filled up to the required level with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the engineer at the own risk and cost of the contractor.

Suitable slope in cutting as per the requirements and as directed by the engineer shall be adopted to withhold the face of earth. The contractor shall be held responsible for any damage to any part of the work caused by the collapse of the side of excavations.

5.03.01 Excavation in Hard Rock

Excavation in hard rock shall normally be done with blasting. In case where blasting is prohibited for any reasons, the excavation shall be carried out by chiselling or any other approved method as directed by the engineer. Personnel deployed for rock excavation shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces.

5.03.02 Blasting

a) General

Storage, handing and use of explosives shall be governed by the current explosive rules/regulations laid down by the Central and the State Governments. The contractor shall ensure that these rules/regulations are strictly adhere to. The following instructions are also to be strictly followed and the instructions wherever found in variance with the above said rules/regulations, the former (instructions) shall be superseded with the later (above said rules/regulations).

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives. The contractor shall obtain licence from the District Authorities for undertaking the blasting work as well as for obtaining and storing the explosives as per Explosives Rules, 1940 corrected upto date. The contractor shall purchase the explosives, fuses, detonators etc only from a licensed dealer and shall be responsible for the safe custody and proper accounting of the explosive materials. The engineer or his authorized representative shall have the access to check the contractor's store of explosives and his accounts at any time. It is the full responsibility of the contractor to

transport the explosives as and when required for the work in a safe manner to the work spot.

Further, the engineer may issue modifications, alterations and new instructions to the contractor from time to time. The contractor shall comply with the same without these being made a cause for any extra claim.

b) Materials

All materials such as explosives, detonators, fuses, tamping materials etc proposed to be used in the blasting operation shall have the prior approval of the engineer. Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used. The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and shall be not less than 4 seconds per inch of length with 10% tolerance on either side. Before use, the fuse shall be inspected. Moist, damaged or broken ones shall be discarded. When the fuses are in stock for long, the rate of burning of fuses shall be tested before use. The detonators shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

c) Storage of Explosives

The current Explosive Rules shall govern the storage of explosives. Explosives shall be stored in a clean, dry and well-ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400m of the actual work site or any source of fire. The space surrounding the magazine shall be fenced and the ground inside shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be through a single gate only and no person shall be allowed without the permission of the officerin-charge. The clear space between the fence and the magazine shall not be less than 90m. The magazine shall be well drained. Two lightning conductors, one at each end shall be provided to the magazine. The lightning conductors shall be tested once in every year.

Explosives, fuses and detonators shall each be separately stored. Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care shall be taken to keep the floor free from any grains of explosives. Cases containing explosives shall not be opened inside the magazine and the explosives in open cases shall not be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine but must be removed without delay to a safe distance and be destroyed.

Artificial light, matches, inflammable materials, oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100m distance from any magazine. Magazine shoes without nails shall be used while entering the magazine. The persons entering the magazine must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful

* not to put their feet on the clean floor unless the magazine shoes on.

* not to touch the magazine shoes on ground outside the clean floor.

* not to allow any dirt or grit to fall on the clean floor.

Persons with bare feet shall dip their feet in water before entering the magazine and then step directly from the tub to the clean floor. No person having article of steel or iron with/on him shall be allowed to enter the magazine. Workmen shall be examined before entering the magazine to check none of the prohibited articles are with them. A brush broom shall be kept in the lobby of the magazine for cleaning the magazine. Cleaning shall be done immediately after each occasion whenever the magazine is opened for receipt, delivery or inspection of the explosives.

The mallets, levers, wedges etc for opening the barrels or cases shall be of wood. The cases of explosives are to be carried by hand and shall not be rolled or dragged inside the magazine. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been stored long in the store are to be issued first. Neither the magazine shall be opened nor any person shall be allowed in the vicinity of the magazine during any dust storm or thunderstorm. All magazines shall be officially inspected at definite intervals and a record of such inspections shall be kept.

d) Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from direct rays of the sun, artificial lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each case or package shall be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on the vehicle conveying explosives. No explosive shall be transported in a carriage or vessel unless all iron or steel therein the carriage or vessel which are likely to contact the package containing explosives are effectually covered with lead, leather, wood, cloth or any other suitable material. No light shall be carried on the vehicle carrying explosives and no operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

e) Use of Explosives

The contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with his responsibilities. Holes for charging the explosives shall be drilled with pneumatic drills and the drilling pattern shall be so planned that the rock pieces after blasting will be suitable for handling. The hole diameter shall be of such a size that the cartridges can easily pass down through them and any undue force is not required during charging. Charging operation shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed

from the explosive cartridges. Only one cartridge at a time shall be inserted in a hole and wooden rods shall only be used for loading and stemming the shot holes. Only such quantities of explosives as are required for a particular work shall be brought to the work site. Should any surplus remain when all the holes have been charged shall be carefully removed to a point at least 300m away from the firing point.

The authorized shot firer himself shall make all the connections. The shot firing cable shall not be dragged along the ground to avoid any damage to the insulation. The shot firing cable shall be tested each time for its continuity and possible short circuiting. The shot firer shall always carry the exploder handle with him until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits. Before any blasting is carried out it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300m radius from the firing point or as required by the statutory regulations at least 10 minutes before the time of firing by sounding a warning siren and the area shall be encircled by red flags.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges, the electric detonators shall be connected with the exploder through the shot firing cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current etc and keep the lead wires short circuited until it is ready to fire. Any kink in the detonator leading wire shall be avoided. For simultaneous firing of a large number of shot holes, use of cordtex may be done. An electric detonator attached to its side with adhesive tape shall initiate cordtex connecting wire or string. Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the engineer.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorized shot firer shall return to the blast area and inspect carefully the work and satisfy himself that all the charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole at a distance of not less than 600mm from the misfired hole and by exploding a new charge. The authorized shot firer shall be

present during the removal of debris as it may contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Where blasting is to be carried out in proximity of other structures, controlled blasting by drilling shallow shot holes and proper muffling arrangements with steel plates loaded with sand bags etc shall be used on top of the blast holes to prevent the rock fragments from causing any damage to the adjacent structures and other properties. Adequate safety precautions as per building byelaws, safety codes, statutory regulations etc shall be taken during blasting operations.

5.03.04 Restrictions on Blasting

a) Blasting which may disturb or endanger the stability, safety or quality of the adjacent structures/foundations shall not be permitted.
b) Blasting within 200m of a permanent structure or construction work in progress shall not be permitted.
c) Progressive blasting shall be limited to two third of the total remaining depth of excavation.
d) No large scale blasting operations will be resorted to when the excavation reaches the last one metre and only small charge preferably black powder may be allowed so as not to shatter the parent rock.
e) The last blast shall not be more than 0.50 m in depth.
f) In rocky formations, at locations where specifically indicated or ordered in writing by the engineer, the use of explosives shall be discontinued and excavation shall be completed by chiselling or any other suitable method as approved by the engineer.

5.04 Sorting of Excavated Materials

The excavated material shall be carefully sorted for use in filling the areas in the project site by removing roots, grasses, organic matters and other objectionable materials and be sorted out into different types of materials for use and as directed by the engineer. The excavated material which is not considered fit for filling purpose shall be immediately removed and disposed at such a place and in such a manner as will be directed by the engineer. The material found unusable should be got approved by the engineer before actually disposing it off. The useful materials that cannot be used directly shall be heaped in separate area as stock piles. Stockpiles shall be of regular size as for as possible for ease of measurement. The materials heaped shall be utilised as and when required and as directed by the engineer. The cost of complete item of earthwork includes the cost of rehandling of the materials and temporarily heaped and reused.

5.05 Disposal of Surplus/ Waste Materials

Surplus and other waste materials shall be removed and disposed of from the construction site to the area demarcated by the engineer. No material shall be wasted unless approved by the engineer.

5.06 Earth Work in Filling

Levelling by raising with controlled fill of approved excavated/borrowed earth shall be carried out where the existing ground levels are lower than the specified formation level. After clearing site as per clause 5.01, the original ground shall be compacted by rolling subject to a minimum 6 passes of 8 to 10 tonne roller. The approved earth/fill material shall then be spread in horizontal layers not exceeding 300mm in compacted thickness. Each layer shall be watered and thoroughly compacted with proper moisture content and such equipments as may be required to obtain a minimum of 95% of its maximum dry density as

determined by standard Proctor's test as per IS: 2720 part-VII or 85% of relative density as per IS:2720 part-XIV as specified. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The fill material shall be tested for its optimum moisture content and maximum dry density as per IS: 2720, part-VII. Moisture content shall be checked at the source of supply in accordance with IS:2720 part- II and if found less than that required for proper compaction, the same shall be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case, water shall be sprinkled directly from the hose line or from the truck-mounted water tank etc making due allowance for evaporation losses and the fill material be thoroughly mixed by means of harrows, rotary mixers or by any other suitable approved method until the layer is uniformly wet. **Flooding shall not be permitted for watering purpose under any circumstances.** If the material delivered is too wet, it shall then be dried by aeration and exposure to the sun till the moisture content is suitable for compaction. Should circumstances arise owing to wet weather the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended. Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the layers before compaction. For each of the above tests on the fill material, one sample for every 10,000cu.m shall be tested. Additional samples shall be tested whenever there is a change of source or type of material.

Before start of filling, the contractor shall submit the engineer his proposal for the methodology to be adopted for compaction. The compaction equipments as approved by the engineer shall only be employed to compact the different type materials encountered during construction. If directed by the engineer, the contractor shall demonstrate the efficacy of the plant he intends to use by carrying out compaction trials. Moisture content of the fill material shall be controlled near optimum moisture content during compaction.

The compacted layer shall be tested for its dry density as per IS:2720**,** part-XXVIII or XXIX as directed by the engineer. Samples shall be taken at the rate of one sample for every 10,000sq.m area of each compacted layer. In addition random checks shall be carried out in compacted layers by means of Proctor needle penetration test. Contractor shall submit all the test results to the engineer immediately after completion of the tests. A sample shall be deemed to have passed the test when the dry density of the compacted fill is equal to or more than 95% of its maximum dry density. When field density measurements reveal any soft areas in the fills, further compaction shall be carried out as directed by the engineer. If in spite of that, the specified compaction is not achieved, the material in the soft areas shall be replaced with approved material compacted to the density requirements and satisfaction of the engineer.

Subsequent layers shall be placed only after the finished layer has been tested and accepted by the engineer.

Where the filling is to be done across low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed

layer of a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

5.07 Dewatering and Drainage

It shall be ensured that the area to be excavated/filled shall be free from water. The contractor shall remove the water (if any) by pumping or by any other means as approved by the engineer. At all times, the surface of cutting/filling during execution shall be maintained at such a cross fall as will shed water and prevent ponding. All existing drains/channels (if any) in the work area shall be suitably diverted by the contractor before taking up any excavation or filling. These diversions shall be such that it shall ensure effective disposal of water without any accumulation or flooding within the project site and in adjoining areas.

5.08 Finishing Operations

Finishing operation shall include the work of shaping and dressing the excavated/filled ground to the required grades, levels, lines, side slopes, crosssections
and dimensions as shown on the approved drawings or as directed by the engineer.

5.09 Turfing

Turfing shall be provided at the slopes and other locations as shown on the drawings or as directed by the engineer. The turf shall be of approved quality of grass. The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically free from weeds or other undesirable matter. The grass on the sod shall have a length of approximately 50mm and the sod shall be free of any

debris. Thickness of the sod shall be as uniform as possible with 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that all the dense root system of the grasses are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than about 300mm x 250mm size but not so large so that it is convenient to handle and transport without damage.

The area to be sodded shall be previously constructed to the required slope and cross section. Prior to placing the sods, the slopes shall be **roughned** and wetted in order to have a satisfactory bond. The strips of sod shall be laid in close contact with each other and be tamped firmly in place so as to fill and close the joints between them. The turfing so laid shall be well watered and protected until final acceptance.

5.10 Approaches

The contractor shall provide proper approaches for workmen and inspection.

5.11 Lighting

Full scale lighting are to be provided if night work is permitted or directed by the engineer. If no night work is in progress, red warning lights should be provided at the edges of excavations and fills.

6.00 RATES AND MEASUREMENTS

6.01 Rates

a) The item of work in the schedule of quantities describe the work very briefly. The various items of the schedule of quantities shall be read in conjunction with the corresponding sections in the technical specification including amendments and additions if any. For each item in the schedule of quantities, the bidder's rate shall include all the activities covered in the description of the items as well as for all necessary operations in detail as described in the technical specification.

b) No claims shall be entertained if the details shown on the released for construction drawings differ in any way from those shown on the tender drawings.

c) The unit rate quoted shall include minor details which are obviously and fairly intended and which may not have been included in these documents but are essential for the satisfactory completion of the work.

d) The bidder's quoted rate shall be inclusive of supplying and providing all labour, men, materials, equipments, tools and plants, supervision, services, approaches, schemes etc.

6.02 Measurements

Method of measurements are specified in the proceeding sections. Where not so specified, the latest version of IS:1200, Part-1 shall be applicable.

a) The length, breadth and depth shall be measured correct to the nearest centimetre if measurements are taken by tape. Rounding of numericals shall be as per relevant IS Codes. If the measurements are taken with staff and level, the levels shall be recorded correct to 5mm. The area and volume shall be worked out in square meter and cubic meter correct to the nearest of two decimal places.

b) For earth work in excavation, the ground levels shall be taken before and after completion of the work in the actually excavated area. The quantity of earth work in cutting shall be computed from these levels in cubic meter.

c) Where soft rock and hard rock are mixed, the measurement shall be done as follows. The two types of rock shall be stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in the stacks. If the sum of net quantity of the two types of rock so arrived exceeds the total quantity of excavation then the quantity of each type of rock shall be worked out from the total quantity (from excavation) in the ratio of net quantities in stack measurements of the two types of rock. If stacking is not feasible, the method as suggested by the engineer shall be followed.

d) Where soil, soft rock and hard rock are mixed, the measurement shall be done as follows. The soft and hard rock shall be removed from the excavated material and stacked separately and measured in stacks. The net quantity of each type of rock shall be so arrived by applying a deduction of 50% for looseness/voids in stacks. The difference between the entire excavation and the sum of the quantities of soft and hard rocks so arrived shall be taken as soil.

e) For earth work in filling, the actual measurements of fill shall be calculated by taking levels of the original ground before start of the work but after site clearance and after compaction of fills. The quantity of earth work in filling shall be computed from these levels in cubic meter.

f) For turfing, the measurement shall be made on the finished work in square meter.

VOLUME: II B

SECTION - D

SUB-SECTION – D9

MASONRY AND ALLIED WORKS

SPECIFICATION NO. PE-TS-999-600-C009

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	PAGE NO.
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MASONRY AND ALLIED WORKS

1.00.00 SCOPE

This section covers furnishing, installation including handling, transporting, batching, mixing, laying scaffolding, centering, shuttering, finishing, curing, protection, maintenance and repair of common building materials till handing over of masonry and allied works for use in structures and locations covered under the scope of this package.

2.00.00 MATERIALS

a) Brick

Bricks for general masonry work shall be of class designation 7.5 of nominal dimensions as per standard specification under IS: 1077, well burnt, of uniform size, shape and colour, free from cracks, flaws or modules of free lime and emit clear ringing sound when struck. Fractured surface shall show uniform texture free from grits, lumps holes etc. Water absorption after 24 hours immersion shall not exceed 20% by weight for bricks. Dimensional tolerance shall not exceed 8% of the size shown in drawings for bricks. All bricks shall have rectangular faces and sharp straight edges. The bricks shall show no efflorescence after soaking in water and drying in shade.

Each brick shall have the manufacturer's identification marks clearly marked on the frog. Representative samples shall be submitted and approved samples shall be retained by the Engineer for further comparisons and reference. Any brick not found up to the specification shall be removed immediately from site at the Contractor's own cost.

Bricks shall not be dumped at site. They shall be stacked in regular tiers, even as they are unloaded; to minimize breakage and defacement of bricks. Bricks selected for different situation of use in the work shall be stacked separately.

b) Stone

All stones shall be obtained from approved quarries, hard, tough, durable compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean, and sharp and shall show uniformity of texture, without

loose grains and free from any dull, chalky, or earthly appearance. Stone showing mottled colours shall not be used for face work. A stone shall not absorb more than 5 per cent of its weight of water after 24 hours immersion. The type of stone shall be as specified on drawings and/or instructed by the Engineer. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

c) Cement

Cement used shall be Ordinarily Portland Cement or Portland Slag Cement or Portland Pozzolana Cement conforming to IS Codes and shall be fresh when delivered. In special cases, Rapid Hardening Portland Cement, Low Heat Cement etc. may be permitted or directed to be used by the Engineer. The Contractor shall submit the manufacturer's certificate for each consignment of cement procured to the Engineer. If at any time, the Engineer feels that the cement being used by the Contractor is not up to specification, he may stop the work and send the samples of the cement to a testing laboratory for standard tests and all expenses incurred thus shall be borne by the Contractor. The Contractor shall also have no claim for this type of suspension of work.

The cement shall be stored above the ground level in perfectly dry and watertight sheds. The bags shall be stacked in a manner so as to facilitate removal or first in first out basis. Any material considered defective by the Engineer shall not be used by the Contractor and shall be removed from the site immediately.

d) Coarse Aggregate

Coarse aggregates shall be as per IS: 383 latest editions, consisting of hard, strong and durable pieces of crushed stone and shall be free from organic or clay coatings and other impurities like disintegrated stones, soft flaky particles etc. and any other material liable to affect the strength, durability or appearance of concrete.

Aggregates other than crushed stone conforming to the provisions of specification may be used if permitted by the Engineer.

Washing of aggregates by approved means shall be carried out, if desired by the Engineer.

Grading of coarse aggregates shall generally conform to IS: 383 and shall be such as to produce a dense concrete or the specified proportions and strength and of consistence that will work readily into position without

segregation.

Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass, or any other injurious substances at any stage.
Aggregate of different size shall be kept in separate stacks. If so desired by the Engineer aggregate from different sources shall be stacked separately with proper care to prevent intermixing.

e) Sand

Sand shall be hard, durable, clean, and free from adherent coatings or organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale or other laminated materials in such forms or quantities as to affect adversely the hardening, strength, durability or appearance of mortar, plaster or concrete or to cause corrosion to any metal in contact with such mortar, plaster or concrete. All sand shall be properly graded and shall be as per relevant IS Code. Sand for concrete shall conform to IS: 383.

f) Water

Water shall be clean, fresh and free from organic matters, acids or soluble salts and other deleterious substances which may cause corrosion, discoloration, efflorescence etc.

g) Reinforcement

Reinforcement steel shall be clean and free from loose mill scales, dust, loose rust, oil and grease or other coatings, which may impair proper bond. Structural steel shall conform to IS: 2062. Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement shall conform to IS: 432. Cold twisted steel bars shall conform to IS: 1786. Hand drawn steel wire fabric shall conform to IS: 1566. Hexagonal wire netting shall conform to IS: 3150. All steel bars including and above 10 mm diameter shall be of tested quality. All wire netting shall be galvanized.

Reinforcement bars shall be stored off the ground and under cover if so desired by the Engineer. If necessary, a coat of cement wash shall be given to the bars to guard against rusting.

3.00.00 INSTALLATION

3:01.00 Soling

3.01.01 Brick Soling

The ground shall be dressed, consolidated by ramming, or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. The pattern of laying and number of layers shall be as per Schedule of item. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

3.01.02 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling specified in the Schedule of Items. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

3.02.00 Brick-on-Edge

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

3.03.00 Masonry

3.03.01 General

All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

3.03.02 Cement Mortar

Cement mortar shall be prepared with materials specified in clause 2.00.00. Sand for masonry mortar shall conform to IS: 2116. Cement and sand in the specified proportion shall be mixed dry thoroughly and minimum water added to attain required workability.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement without any extra payment. No mortar, which has stood for more than half an hour, shall be used.

3.03.03 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing.

Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

3.03.04 Exposed Brickwork

Brickwork in superstructures, which is not covered by plaster, shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule, and string. All brickwork shall be cleaned at the end of days work. If face bricks are specified, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean, and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

3.03.05 Reinforced Brickworks

Reinforcements shall be as specified. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

3.03.06 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.03.07 Exposed Stone work

Stonework, which is to be kept exposed, shall be as shown on approved drawing. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 Sq.M. area shall be built and approved by the Engineer and all works shall match with this sample.

3.03.08 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

3.03.09 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings and specified. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard waterproof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer.

3.03.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with Carborundum stone.

3.03.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

3.03.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

3.03.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc., and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

3.04.00 Damp Proof Course (DPC)

Unless otherwise specified Damp-proof course shall be 40 mm thick 'artificial stone' in proportion 1:1½:3 cement sand stone-chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by ponding for seven days.

3.05.00 Damp Proof Membrane

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as shown as drawings or as specified. Sequence of work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged, at his own expense, to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.05.00 Plinth Protection

Plinth of buildings shall be protected with brick-on-edge paving of minimum 750mm width unless otherwise shown on the drawings. The treatment shall

consist of laying bricks in cement mortar 1:6 (1 cement: 6 sand) over a 75mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. The top shall be finished with 1:2 cement mortar pointing (1 cement: 2 sand). Plinth protection shall be laid with a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly overbumt and dense brickbats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required slope around the building. The high portions of the ground should be cut down; hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed with heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50m or as directed by the Engineer.

Over this, 75mm thick bed of aggregate of 40mm nominal size, shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.6 cubic metre per square metre area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the subgrade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement: 6 sand) shall be laid.

The bricks shall be laid on edge in Diagonal/Herring Bone Bond or other paftem as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The pointing shall be done in cement mortar 1:2 (1 cement: 2 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge. The mortar shall not spread over surface of the masonry.

Brick flooring & pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

4.00.00 I.S. CODES

Some of the important relevant codes for this section are:

IS: 1127: Recommendations for dimensions and workmanship of natural building stones for masonry work.

IS: 1597: Code of Practice for Construction of stone Masonry.

IS: 1609: Code of Practice for laying Damp proof treatment using bitumen felts.

IS: 2212: Code of Practice for Brickwork.

IS: 2250: Code of Practice for preparation and use of masonry Mortar.

IS: 5134: Bitumen Impregnated Paper & Board.

5.00.00 RATES AND MEASUREMENTS

5.01.00 Rates

Unit rate for masonry work shall include the following:

a) Raking out joints for plastering or pointing or finishing the joint flush as the work proceeds.

b) Preparing top sand sides of existing wall for joining old with new work.

c) Providing, dismantling and removing the scaffolding.

Unit rate for DPC shall be inclusive of formwork and bitumen painting.

5.02.00 Measurement

Brickwork in wall of half brick thickness shall be measured separately in Sqm stating the wall thickness and more than half brick thickness shall be measured by volume. Plaster thickness shall not be considered for computation of volume.

Masonry work in sub structure and super structure shall be measured separately, unless otherwise specified in the Schedule of items.

No deductions shall be made and no extra payment shall be made for following:

a) Opening upto 0.1 Sqm each in area. In calculating the area of the opening lintels or sills shall be included along with the size of the opening.

b) Drainage holes and recesses for cement blocks to embed holdfasts for doors, windows etc.

c) Pipe and fixtures upto 300mm dia. and nothing extra shall be paid for the mortar used for fixing.

d) Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc); up to 0.1 sqm in section;

e) Chases of section not exceeding 50 cm in girth;

f) Iron fixtures, such as wall ties and hold fasts for doors and windows;

g) Cement concrete blocks as fcr hold fasts and holding down bolts;

h) Wall plates, bed plaros, and bearing of slabs, CHAJJAS and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;

Reinforcement in masonry work shall be paid separately under respective items.

Damp proof course shall be measured in Sqm. No deduction shall be made and no extra shall be paid for opening upto 0.1 Sqm in area.

Plinth protection shall be measured under respective item of works executed required for completion of the work as specified.

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SECTION - D

SUB-SECTION – D11

PAINTING, WHITEWASHING, POLISHING

SPECIFICATION NO. PE-TS-999-600-C011

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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PAINTING, WHITE WASHING, POLISHING, ETC.

1.00.00 SCOPE

This section covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster of paris, false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items.

Copper, bronze, chromium plate, Nickel, stainless steel and aluminium shall generally not be painted or finished except if otherwise specified.

Before commencing painting, the Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage; disfiguration or staining to work of other trades or other installations.

2.00.00 INSTALLATION

2.00.01 Materials

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible and paint of one shade is obtained from the same manufacturing batch. Each and every supply of primer, finish paint etc. shall be accompanied by manufacturer's test certificate. All paint shall be subject to analysis from random samples taken at site from painters bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finished coats to be applied.

All unspecified materials such as snellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognized manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

a) White Wash/Colour Wash

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the engineer, and shall conform to IS: 712 latest editions. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 liters of white wash water and a little of indigo or synthetic ultramarine blue shall be added to the lime. Mineral colour not affected by lime shall be added to white wash to get the required tint/shade approved by the Engineer.

b) Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water-soluble binders etc. and share conform to IS: 427. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacture. Only sufficient quantity of distemper required for a day's work shall be prepared.

c) Oil Bound Washable Distemper

Shall be of oil emulsion type containing suitable preservatives and shall conform to IS: 428. The distemper shall be diluted with prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for a day's work shall be prepared.

d) Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall conform to IS: 5410.

e) Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with rutile titanium dioxide and other selected pigments and fungicide conforming to IS: 5411 (Part-1). It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild soap and water without any deterioration in colour, or without showing flaking, blistering, or peeling.

f) Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and resist interior surfaces. White and pastel shades shall not yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

g) Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

h) Varnishing

Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

i) French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS: 348.

French polish shall not be used on bare wood it shall only be used as finishing coat on wood after the woods pretreated with a liquid wood filler conforming to IS: 345 is applied and rubbed out.

j) Bitumen paint (black bituminous anti-corrosive paint)

Bitumen based anti-corrosive paint conforming to IS: 158 shall be used.

2.00.02 Storage

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement, & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the contractor to prevent fire.

2.01.00 Preparation of surface

Before starting the work the Contractor shall obtain the approval of the Engineer regarding the soundness & readiness of the surface to be painted on.

2.01.02 Wood

All surfaces shall be free from, dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellace coating applied thinly & extended 25 mm beyond the area. All large, loose, or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.01.02 Masonry, Concrete, and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint, or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of resurfacing may lead to the finishing paint being different in shade from, the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with **Mildew or Efflorescence** shall be treated as below:

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7g of copper carbonate dissolved in 80ml liquor ammonia and diluted to water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.01.03 Metal

The surface preparation shall be done in accordance with IS:1477(Part-1) 'Code of practice for painting of ferrous metals in building' and as directed by Engineer. All metal surfaces shall be absolutely clean, dry, and free from rust, scales, weld slag, flux deposit, wax, grease, dried soap films, foreign matters like cement mortar etc and free from existing loose red oxide zinc chromate primer and should be removed by means of wire brushes, hand scrappers, sand paper, emery cloth, emery papers, or by mechanical power tools etc. or as directed by Engineer. For exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanized iron surfaces shall be pretreated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat. The actual painting work should be commenced only after obtaining clearance from the Engineer regarding proper cleaning of the surface.

2.02.00 Application

2.02.01 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings used shall be independent of the surface to be painted to avoid shade differences of the freshly repaired anchor notes.

Painting shall be done by skilled labours in a workmanlike manner. All materials shall be evenly applied so as to free of sags, runs, crawls, or other defects. All coats shall be of proper consistency. In case of application by brush, no brush marks shall be visible. The brushes shall be clean and in good condition before application of paint.

All priming undercoat for painting shall be applied by brush only, and rollers spray equipments etc. shall not be used.

No work shall be done under conditions that are unsuitable production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint, which seals the surfaces to moisture shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered property by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall, be done as per IS: 1477 (Part I & 2). The total dry thickness of film should not be less than 120 Micron.

2.02.02 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before white washing.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required the Contractor shall do so without any extra cost to the Owner. No brush marks shall show on the finished surface.

2.02.03 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for 24 hours after which the wall shall be thoroughly washed with clean water. For cement-plastered surface, the surface shall be washed with solution of 100 gms. of zinc sulphate to 1 litre of water and allowed to dry.

Dry distempering shall be done as per manufacturers instruction. In applying the distempers the brush, should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long, otherwise brush marks may result.

2.02.04 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per manufacturer's instruction.

2.02.05 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.02.06 Acrylic Emulsion Paint

Paint shall be applied after providing one coat of cement primer solvent of approved quality and primer shall be conform to IS: 109. Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be done strictly as per manufacturer's specification.

2.02.07 Synthetic Enamel Paint

Shall be applied on properly primered surface. Subsequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.02.08 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.02.09 Clear Synthetic Varnish

The Varnish shall be applied on wood surface after (a) filling, (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on white the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has begun to set shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down, before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.02.10 French polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted .The pores in the shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemme or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit, and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.02.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber, or vinyl butryl paint system shall be used. Manufacturer's recommendation shall be followed regarding the paint system, exposed to moderately to severe corrosive condition and subject to acid/alkali spillage & fumes, shall be followed.

2.03.00 Protection

Furniture and other movable objects, equipment, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipment shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.04.00 Cleaning up

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been splashed or splattered, including all equipment, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.00.00 ACCEPTANCE CRITERIA AND TESTING

a) All painted surfaces shall be uniform and pleasing in appearance.

b) All varnished surfaces shall be of uniform texture and high glossy finish.

c) The colour, texture etc. shall match exactly with those of approved samples.

d) All stains, splashes, and splatters of paints and varnishes shall be removed from surrounding surfaces.

Testing

a) As, each part of the work is under progress, i.e. preparation of surface, providing primer, providing different coats of finishing paints, it shall be passed by the Engineer. Variation from the drawings or specification or standard etc. shall not be accepted. The Contractor shall ascertain from the Engineer as to which parts will be inspected and passed from time to time. The Contractor shall provide all necessary arrangement for inspection of the painting work during its different working phase. The Contractor shall provide necessary scaffolding, approach for inspection of the above as per direction and satisfaction of the Engineer. All the necessary cost for scaffolding, approach, platform, lighting arrangement testing and inspection shall be borne by the Contractor. Such inspection and testing will not, however, exonerate the Contractor from his responsibilities for proper workmanship, material etc.

b) The Contractor shall carry out all sampling and necessary testing in accordance with the relevant Indian Standards and shall conduct such tests as called for by the Engineer. Where no specific testing procedure is mentioned in the relevant codes, the tests shall be carried out as per the prevalent accepted Engineering practice as per the direction of the Engineer. Tests shall be done in a laboratory, approved by the Engineer, and cost of testing shall be borne by the contractor.

c) Material/workmanship unsuitable for acceptance shall he removed and replaced by the Contractor. The work shall be redone as per Specification of the contract and direction of the Engineer without extra cost to owner.

4.00.00 I.S. CODE

All work shall be carried out as per this specification and shall conform to the latest revision and/or replacements of the following or any other Indian Standard (IS) Codes, unless specified otherwise. In case any particular aspect of work is not specifically covered by Indian Standard Codes, any other standard practice, as may be specified by the Engineer, shall be followed.

IS: 348	Specification for French polish
IS: 427	Specification for Distemper, dry colour as required.
IS: 428	Specification for Distemper oil emulsion, colour as required.
IS: 1477 (I & II)	Code of Practice for painting of ferrous metal in buildings.

IS: 2338 (I & II)	Code of Practice for finishing of wood and wood based materials.
IS: 2339	Specification for Aluminium, Paints for general purposes in dual containers.
IS: 2395	Code of Practice for painting concrete, masonry, and Plaster surface.
IS: 2932	Specification for enamel, exterior type-1.
IS: 5410	Specification for cement paint, colour as required.

5.00.00 RATES AND MEASUREMENT

5.01.00 Rates

Rates shall be unit rates for complete items described in the "Schedule of Items".

Rate shall include cleaning, preparation of surface, supply and application of primer, painting and providing all protection and scaffolding required at site.

5.02.00 Measurements

Painting over the concrete/masonry/wooden surface shall be measured net (on the surface area on which it is applied) in Sqm.

No deduction shall be made for opening not exceeding 0.5 Sqm and ends of beams, joints, etc. also no payment shall be made for reveals, jams, soffits, sill of these openings.

50% deduction shall be made for opening exceeding 0.5 Sqm but not exceeding 3.0 Sqm each and no addition shall be made for reveals, jams, soffits, sills etc.

In case of opening exceeding 3.0 Sqm each, deduction shall be made for opening but jams, soffits, and reveals shall be measured and paid for.

Corrugated surfaces shall be measured flat and measured area shall be increased by 15%.

Painting of structural steel works shall be measured in M.T. of fabricated steel (as per section D-17 clause 6.02.00 i.e Mode of measurement of technical specification for fabrication of structural steel works) unless specified otherwise.

VOLUME: II B

SECTION - D

SUB-SECTION – D16

SPECIFICATION NO. PE-TS-999-600-C016

ROAD AND DRAINAGE

Maharatna Company

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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2.00.0	CODES AND STANDARDS	4
3.00.0	EXECUTION	7
4.00.00	TESTING AND ACCEPTANCE CRITERIA	36
5.00.00	MEASUREMENT	36

Standard Technical Specification
For Road and Drainage

1.00.00 Scope

The scope include all works required for the construction of road including construction of embankment, sub-base course, base course, tack coat, bituminous macadam, wearing course, liquid seal coat, shoulder and all incidental items of work specified or not shown but reasonably implied or necessary for the completion of the work etc.

The scope also include all works required for the construction of drainage including construction of road side drains, RCC culverts, pipe culverts, drainage pipes, manholes and all other incidental items necessary for the completion of the work etc.

1.01.00 Works To Be Provided By The Contractor

The works to be provided by the contractor unless specified otherwise shall include but not be limited to the following.

a) Construction of roads including providing all materials, labour, supervision, services, equipments, tools and plants, transportation etc all required for the completion of the work.

b) Submission of detailed scheme of all operations required for executing the work (e.g. material handling, placement, services, approaches etc) to the engineer for approval.

c) Carrying out tests whenever required by the engineer to assess the quality of work and submission of the test results to the engineer after completion of the same etc.

1.02.00 Work To Be Provided By Others

No work under this specification will be provided for by any agency other than the contractor unless specifically mentioned elsewhere in the contract.

1.03.00 Conformity With Designs

The contractor shall carryout the work as per the construction drawings, specification and as directed by the engineer.

1.04.00 Materials To Be Used

All materials required for the work shall be the best commercial variety and as approved by the engineer.

2.00.00 Codes and Standards

All works under this specification shall conform to the latest revision and/or replacement of the following or any other IRC/IS Codes and Standard Practices unless specified otherwise.

a) Specification for road and bridge works of Ministry of Shipping & Transport (Road Wing) Published by the IRC

b) IRC: 19 - Standard specification and code of practice for Water bound Macadam

c) IRC :SP 11 - Hand Book of Quality Control for Construction of Roads and Runways

d) IS:456 - Indian Standard Code of Practice for Plain and Reinforced Concrete.

e) IS:2212 - Code of Practice for Brick work

f) IS: 783 - Code of Practice for Laying of Concrete Pipes

g) IS: 1201 - Methods of testing tar and bituminous materials to 1220

h) IS: 73 - Specification for paving bitumen

i) IS: 215 - Specification for Road tar

j) IS: 216 - Coal tar pitch

k) IS: 217 - Specification for cut-back bitumen

l) IS: 454 - Specification for cut-back bitumen from waxy crude

m) IS: 1834 - Specification for hot applied sealing compound for joint in concrete

n) IS: 1838 - Specification for performed fillers for expansion joints in concrete, non extruding and resilient type
Part I Bitumen impregnated fibre

Part II CNSL Aldehyde resin and coconut pith

o) IS : 334 - Glossary of terms relating to bitumen and tar

p) IS: 1077 - Common burnt clay building bricks

q) IS : 3117 - Specification for bitumen emulsion roads (anionic type)

r) IS : 1200 - Method of measurement of building and civil engineering work (Part-17)- Road work including airfield pavements

s) Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification/Indian Standard Code of practices, any other standard practice as may be specified by the engineer shall be followed.

2.01.00 Quality Control

The Contractor shall establish and maintain quality control for all materials, procedures, workmanship and equipments used. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings, specification and as directed by the engineer. Permitted tolerances for road works are described hereinafter.

a) Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of the pavement shall be ± 40mm.

b) Longitudinal Profile

The finished levels of the sub-grade and different pavement courses as constructed shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the engineer and shall not exceed the tolerances as mentioned below.

Sub-grade	± 25 mm
Sub-base	± 20 mm
Base course	± 15 mm
Wearing course	± 10 mm

Tolerance in wearing course shall not be permitted in conjunction with the

positive tolerance on base course if the thickness of the wearing course is thereby reduced by more than 6 mm.

c) Surface Regularity of Sub-grade and Pavement Courses

The surface regularity of the completed sub-base, base course and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table - I. The longitudinal profile shall be checked with a 3m long straight edge at the middle of each traffic lane along a line parallel to the centre of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10m.

TABLE –I

PERMITTED TOLERANCE OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sl. No.	Type of Construction	Longitudinal profile with 3m straight edge					Cross Profile
		Maximum permissible Undulation (mm)	Maximum number of undulations permitted in any 300m length with undulation exceeding (mm)				Maximum permissible variation from specified profile under camber template (mm)
			18	12	10	6	
1	2	3	4	5	6	7	8
1.	Earthen sub-grade	25	30	-	-	-	15
2.	Granular sub-base	15	-	30	-	-	12
3.	Water Bound Macadam with oversize metal (40-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (20-50 mm and 40-63 mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.	Surface dressing** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous penetration macadam	12	-	-	20	-	8
6.	Open graded premix carpet, mix seal Surfacing	10	-	-	-	30	6
7.	Bituminous macadam	10	-	-	-	20***	6

8.	Semi-dense carpet	10	-	-	-	20***	6
9.	Asphaltic Concrete	8	-	-	-	10***	4

Notes:

1. ** For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2. *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

3. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

3.00.00 Execution

3.01.00 Setting Out

Within 15 days of the award of contract, the contractor shall prepare and submit to the Engineer detailed drawings/schemes of embankment filling and excavation works as proposed to be executed by him showing the dimensions as per construction drawings and specification adding his proposals of drainage and dewatering of pits, watering and compacting the embankment fill etc. On receiving the approval from the Engineer with modifications and corrections if any, the contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the contractor shall proceed with the work. It should be noted that this checking by the Engineer prior to the start of the work will in no way absolve the contractor of his responsibility of carrying out the work to true lines and levels as per the approved drawings. If any errors are noticed in the Contractor's work at any stage, the contractor at his own risk and cost shall rectify the same. Profiles of the embankment made with Bamboo, earth or other convenient materials and strings shall be set up at suitable intervals for the guidance of the workmen.

3.02.00 Clearing and Grubbing

Before commencement of earthwork, the surface area of ground to be occupied shall be cleared of all fences, trees, logs, stumps, bushes, vegetation, rubbish, slush etc. Cutting of trees shall include trees having girth of any size and removing roots upto a depth of 600mm below ground level or 300mm below formation level whichever is deeper. After the removal of roots of

trees, the pot holes formed shall be filled with good earth in 250mm layers (loose thickness) and compacted unless otherwise directed by the Engineer. The trees shall be cut into suitable pieces as instructed by the Engineer. Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to the approved disposal areas as may be specified. Useful materials, saleable timbers, firewood etc shall be the property of the Owner and shall be stacked properly at the work site in a manner as directed by the Engineer.

3.03.00 Filling in Embankment

3.03.01 General

The material used for constructing the embankment shall be earth, moorum, gravel or a mixture of the above or any other material approved by the Engineer. The material shall be free from lumps and clods, boulders and rock pieces, roots and vegetation, harmful salts and chemicals, organic materials, loose silts, fine sands and expansive clays in order to provide a stable embankment. The filling and compaction operation should be such that the best available materials are saved for the top portion and will result in an acceptable and uniform gradation of material and provide impermeability and stability to the embankment when compacted. The size of the coarse material in the mixture of earth shall ordinarily not exceed 75mm. However the Engineer may at his discretion permit the use of material coarser than the specified if he is satisfied that the same will not present any difficulty as regard to the placement and compaction of the fill material are concerned. Ordinarily, only the materials satisfying the density requirements as given below in Table-II shall be employed for embankment construction.

Table - II

Density Requirements of Embankment Materials

Sl. No.	Type of Work	Maximum laboratory dry density when tested as per IS: 2720 (Part - VII)
1.	Embankment upto 3m height	Not less than 1.44 gm/cc
2.	Embankment exceeding 3m height and embankment of any height subject to long period of inundation	Not less than 1.52 gm/cc
3.	Top 0.5m of the embankment below sub-base and shoulders (where earth shoulders are specified)	Not less than 1.65 gm/cc

Expansive clays exhibiting marked swell and shrinkage properties shall not be used for embankment construction.

The material for embankment construction shall be obtained from approved sources with preference given to the materials available from nearby road excavation or any other excavation under the same contract.

3.03.02 Setting Out

After the site clearance, the work shall be set out true to lines, curves, slopes, grades and sections as shown on the approved drawings or as directed by the Engineer. The contractor shall provide all labour, survey instruments and materials such as strings, pegs, nails, bamboo, stones, lime, mortar, concrete etc required in connection with the setting out of the works and establishment of the bench marks. The limits of the embankment shall be marked by fixing batter pegs on both sides at regular intervals as guides before commencing the earthwork. To ensure the safety, the pegs should normally be fixed about 500mm away from the actual limits of the fill and to be painted in a distinct colour. The centreline of the embankment shall be pegged at regular intervals of 25/30m and at all skews/curves. The actual profile of the embankment shall be made at every third centre line peg with bamboo posts and strings. Preferably prototype profiles developed with wooden planks need to be fixed at every 200m and at the intersection points at curves. The profile shall be about 3m long.

3.03.03 Stripping and Storing top soil

The construction of the earthen embankment by filling shall conform to the dimensions, slopes and other details shown in the approved drawings. Before commencement of the embankment construction, the surface area of ground to be occupied after clearing and grubbing shall be stripped off to a minimum depth of 150mm or more as directed by the Engineer in order to remove all perishable materials and any soil which may become unstable on saturation or may interfere with the development or proper bonding between the foundation and embankment. It is not necessary to remove all the soil containing fine hair like roots but only the rather heavy mats are to be removed. In localities where most of the available embankment fill materials are not conducive to plant growth or when so directed by the Engineer, the top soil suitable for plant growth existing over the embankment foundation areas shall be stripped to specified depths not exceeding 150mm and stored for covering the embankment slopes where revegetation is desired.

3.03.04 Compacting Original Ground

In all cases, the original ground after stripping shall be compacted by rolling with a minimum six passes of 8-10 tonne roller and as directed by the Engineer.

Where the height of the proposed embankment is less than 0.5m and the original ground does not already have a relative compaction of atleast 95 percent of Standard Proctor density (maximum dry density), the same shall be loosened upto a depth of 0.5m and filled in layers not exceeding 250mm in loose thickness and each layer shall be watered and compacted to 100% maximum dry density of the fill material determined in accordance with IS:2720, Part-VII. However before relaying and compacting the loosened material, the surface below this level shall be suitably compacted as directed by the Engineer with a minimum six passes of 8 - 10 tonne roller.

Where so directed by the Engineer, any unsuitable material occurring in the embankment foundation shall be removed and replaced with approved materials suitably compacted. Embankment work shall not proceed until the foundation soil of the embankment is inspected by the Engineer and approved.

3.03.05 Filling

The embankment material shall be spread uniformly over the entire width of the embankment in layers not exceeding 250mm in loose thickness. Successive layers of embankment shall not be placed until the layer under construction has been thoroughly compacted to the requirements set down hereunder. Moisture content of the fill material shall be checked at the source of supply and if found less than that specified for compaction, the same shall

be made good either at the source or after spreading the soil in loose thickness for compaction. In the latter case water shall be sprinkled directly from a hose line or from a truck mounted water tank and flooding shall not be permitted under any circumstances. After adding required amount of water, the soil shall be processed by means of harrows, rotary mixers or by any other approved method until the layer is uniformly wet.

If the material delivered to the road bed is too wet, it shall be dried by aeration and exposure to the sun till the moisture content is acceptable for compaction. Should circumstances arise where owing to wet weather, the moisture content cannot be reduced to the required amount by the above procedure, the work on compaction shall be suspended.

Moisture content of each layer shall be checked in accordance with IS:2720, Part-II and unless otherwise specified shall be so maintained making due allowance for evaporation losses that during compaction, the moisture content shall be in the range of 1 percent above to 2 percent below the optimum moisture content as determined in accordance with IS:2720, Part-VII.

Clods or hard lumps of earth shall be broken to have a maximum size of 150mm when being placed in the lower layers of the embankment and a maximum size of 60mm when being placed in the top 0.5m portion of the embankment below sub-base.

Hauling equipment shall be dispersed uniformly over the entire surface of the previously constructed layer to minimise rutting or uneven compaction.

Where the embankment is to be constructed across a low swampy ground that will not support the weight of trucks or other hauling equipments, the lower part of the fill shall be constructed by dumping successive loads in a uniformly distributed layer to a thickness not greater than that necessary to support the hauling equipment while placing subsequent layers.

3.03.06 Compaction

Compaction equipment approved by the Engineer shall only be employed for construction. If directed by the Engineer, the Contractor shall demonstrate the efficiency of the plant he intends to use by carrying out compaction trials.
Each layer shall be thoroughly compacted to the density as specified in Table-III. Subsequent layers shall be placed only after the finished layer has been tested and accepted by the Engineer.

Table - III

Compaction Requirements For Embankment

Sl. No.	Type of work/material	Field dry density as a percentage of maximum laboratory dry density as per IS : 2720, Part-VII
1.	Top 0.5m portion of embankment below sub-base and shoulders	Not less than 100
2.	Other portions of embankment	Not less than 95

When density measurements reveal any soft area in the embankment, further compaction shall be carried out as directed by the Engineer. If in spite of that the specified compaction is not achieved, the material in the soft area shall be removed and replaced with approved material and compacted to the density requirements and satisfaction of the Engineer.

3.03.07 Drainage

The surface of the embankment at all times during construction shall be maintained at such a cross fall as will shed water and prevent ponding.

3.03.08 Finishing Operations

Finishing operations shall include the work of shaping and dressing the shoulders, road bed and side slopes to conform the alignment, levels, cross sections and dimensions as shown on the drawings or as directed by the Engineer. Both the upper and lower ends of the side slopes shall be rounded off to improve the appearance and merge the embankment with the adjacent terrain.

3.04.00 Turfing With Sods

3.04.01 General

This work shall consist of furnishing and laying live sod of perennial turf forming grass on embankment slopes, shoulders or other locations as shown on the drawings or as directed by the Engineer. Unless otherwise specified the work shall be taken up following the construction of embankment provided the season is favourable for establishment of the sod.

3.04.02 Materials

The sod shall consist of dense, well rooted growth of permanent and desirable grasses indigenous to the locality where it is to be used and shall be practically

free from weeds and other undesirable matters. At the time the sod is cut, the grass shall have a length of approximately 50mm and the sod shall be free from any debris.

Thickness of the sod shall be as uniform as possible with about 50 to 80mm of soil covering the grass roots depending on the nature of the sod so that practically all the dense root system of the grass are retained in the sod strip. The sods shall be cut in rectangular strips of uniform width not less than 250mm x 300mm in size but not so large so that it is convenient to handle and transport without damage. During wet weather the sod shall be allowed to dry sufficiently to prevent rearing during handling and during dry weather it shall be watered before lifting to ensure its vitality and to prevent dropping of soil during handling.

3.04.03 Placing The Sods

The area to be sodded shall be previously constructed to the required slope and cross section. Soil in the area shall be loosened, freed from all stones larger than 50mm size, sticks, stumps and any other undesirable foreign matters etc and brought to a reasonably granular texture to a depth not less than 25mm for receiving the sod.

Where required, top soil shall be spread over the slopes. Prior to placing the top soil, the slopes shall be roughened and wetted in order to have a satisfactory bond. The depth of top soil (to be spread) shall be 75mm.

Following soil preparation and top soiling (if required), fertilizer and ground limestone when specified shall be spread uniformly. After spreading, the materials shall be incorporated in the soil by discing or other means. The prepared sod bed shall be moistened if not already sufficiently moist and the sod shall be placed thereon within 24 hours after the same has been cut. Each sod strip shall be laid in close contact with each other and shall be lightly tamped with suitable wooden or metal tampers so as to eliminate air pockets and to press it into the underlying soil. At points where water may flow over the sod, the upper edges of the sod strips shall be turned into the soil below the adjacent area and a layer of earth shall be placed over it followed by thorough compaction.

3.04.04 Staking the Sods

Where the side slope is 2 to 1 or steeper and the distance along the slope is more than 2m, the sods shall be staked with pegs or nails spaced approximately 500 to 1000mm along the longitudinal axis of the sod strips. Stakes shall be driven approximately plumb through the sods and to be almost flushed with them.

3.04.05 Top Dressing

After the sods have been laid in position, the surface shall be cleaned of any loose sod, excess soil and other foreign materials. Thereafter a thin layer of top soil shall be scattered over the top dressed surface and the area shall be thoroughly moistened by sprinkling water.

3.04.06 Watering and Maintenance

The turfing so laid shall be well watered and protected until final acceptance. Watering shall be done in such a way that no erosion or damage to the sodded areas/embankment occur. The Contractor shall erect necessary warning signs and barriers, repair or replace the sods which are failing to show uniform growth of grass or damaged by his operation and shall maintain the sod at his own cost until final acceptance.

3.05.00 Shoulder Construction

3.05.01 Description

This work shall consist of constructing shoulder on either side of the pavement in accordance with the requirements of this specification and in conformity with the lines, grades and cross sections shown on the approved drawings and as directed by the Engineer.

3.05.02 Materials

Shoulder shall be made of selected earth or granular material as specified conforming to relevant IRC standards.

3.05.03 Construction Operations

Except in the case of bituminous pavements, the shoulders shall be constructed in advance to the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and the area enclosed between the shoulders shall be cleaned of all spilled materials before proceeding with the construction of the pavement layer.

In the case of bituminous pavements, shoulder shall be constructed only after the pavement courses have been laid and compacted.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed without any damage to the

pavement and the area so affected shall be thoroughly cleaned. During all stages of shoulder construction, the required crossfall shall be maintained to drain off surface water.

3.06.00 Kerb

3.06.01 Material

Kerb if required for the construction of footpath shall consist of precast concrete blocks with concrete grade of M-20. The blocks shall be of 100mm thick and of suitable length. The depth of blocks unless otherwise mentioned elsewhere shall be 375mm considering 225mm height of footpath above the road level.

3.06.02 Laying

The kerb shall be laid by cutting trenches of 150mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the kerbs shall be in plumb and the gap between the block shall not be more than 10mm.The gap shall be filled with cement mortar as specified.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.07.00 Sub-base (Granular Sub-base)

3.07.01 Description

This work shall consist of laying and compacting well graded material on the prepared sub-grade in accordance with the specification. The material shall be laid in one or more layers as shown on the drawings and shall conform to the lines, grades and cross sections shown on the drawings and as directed by the Engineer.

3.07.02 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kankar etc or combinations thereof depending upon the grading required. The mixed materials shall be free from organic and other deleterious constituents and conform to one of the three grading given in Table - IV below.

Table - IV
Grading for Granular Sub-base Material

Sieve designation	Percent by weight passing the sieve		
	Grading 1	Grading 2	Grading 3
80 mm 63 mm 4.75 mm 75 micron	100 90 - 100 35 - 70 0 - 20	100 90 - 100 40 - 90 0 - 25	100 90 - 100 50 - 100 0 - 30
Minimum CBR value for the fraction of material passing 20 mm sieve.	30 %	25%	20%

Note : The materials passing 425micron sieve for all the three gradings when tested according to IS : 2720, Part V shall have liquid limit and plasticity index not more than 25 percent and 6 percent respectively.

3.07.03 Physical Requirements

The fraction of materials passing 20mm sieve shall give a CBR value as specified in Table – IV when tested in accordance with IS : 2720, Part XVI after preparing the samples at maximum dry density and optimum moisture content corresponding to IS : 2720, Part VII and soaking the same in water for 4 days.

3.07.04 Spreading and Compacting

Immediately prior to laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetations and other extraneous matters, lightly sprinkled with water if necessary and rolled with one pass of 8 - 10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub-grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of each layer after compaction shall not exceed 150mm.

Moisture content of the loose material shall be checked in accordance with IS : 2720, Part II and shall be suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it shall be from 1 percent above to 2 percent below the optimum moisture content. While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be done with 8 to 10 tonne smooth wheeled rollers or with any other approved plant. Rolling shall commence from the edges and progress towards the centre longitudinally except on super elevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent shall be corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 100% of the maximum dry density of the material determined as per IS : 2720, Part VII. The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose materials. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and recompacted.

3.08.00 Water Bound Macadam Sub-base/Base Course

3.08.01 Description

Water bound macadam shall consist of clean crushed aggregates mechanically interlocked by rolling and bonded together with screenings, binding material wherever necessary and water, laid on the prepared sub-grade or sub-base as the case may be and finished in accordance with the specification and in conformity with the lines, grades and cross-sections shown on the approved drawings.

3.08.02 Materials

a) Coarse Aggregates - General Requirements

Coarse aggregates shall be either crushed or broken stone. The aggregates shall conform to the physical requirements set forth in Table - V.

Table – V

Physical Requirements of Coarse Aggregates for Water Bound Macadam

Sl.No.	Type of Construction	Test	**Test method**	Requirements
1.	Sub-base	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV)	40 percent maximum
			or	
			IS : 5640**	
2.	Base	a) Loss Angeles Abrasion value*	IS : 2386 (Part IV)	50 percent maximum
		or		
		Aggregate Impact Value	IS : 2386 (Part IV)	40 percent maximum
			or	
			IS : 5640 **	
		b) Flakiness Index ***	IS : 2386 (Part I)	15 percent maximum

* Aggregates shall satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar and laterite which get softened in presence of water shall be tested for impact value under conditions in accordance with IS : 5640.

*** The requirements of Flakiness Index shall be enforced only in case of crushed or broken stone and crushed slag.

b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other objectionable matters.

c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table – VI. However the use of Grading-1 shall be restricted to sub-base courses only.

Table - VI
Grading Requirements of Coarse Aggregates

Grading	Size range	Sieve designation	Percent by weight passing the sieve
1.	90mm to 40 mm	100 mm 80 mm 63 mm 40 mm 20 mm	100 65 - 85 25 - 60 0 - 15 0 - 5
2.	63 mm to 40 mm	80 mm 63 mm 50 mm 40 mm 20 mm	100 90 - 100 35 - 70 0 - 15 0 - 5
3.	50 mm to 20 mm	63 mm 50 mm 40 mm 20 mm 10 mm	100 95 - 100 35 - 70 0 - 10 0 - 5

d) Screenings

Screenings to fill the voids in the coarse aggregate shall generally consist of the same material as the coarse aggregates. However where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible, screenings shall conform to the grading set forth in Table-VII. Screenings of Type-A in Table-VII shall be used with coarse aggregates of Grading-1 in Table-VI. Screenings of Type-A or B shall be used with coarse aggregates of Grading-2. Screenings of Type-B shall be used with coarse aggregates of Grading-3.

Table - VII
Grading For Screenings

Grading classification	Size of screenings	Sieve designation	Percent by weight passing the sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90 - 100 10 - 30 0 - 8
B	10 mm	10 mm 4.75 mm 150 micron	100 85 - 100 10 - 30

e) Binding Material

Binding material to be used for water bound macadam construction shall comprise of a suitable material approved by the Engineer having plasticity index value less than 6 as determined in accordance with IS : 2720,Part V. Application of binding material may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.08.03 Construction Operations

a) The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of any dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. Where water bound macadam is to be laid over an existing black topped surface, 50mm x 50mm furrows shall be cut at an angle of 45 degrees to the centre line of the road at 1m intervals in the latter before laying the coarse aggregates.

b) Inverted Choke

If water bound macadam is to be laid directly over the sub-grade without any other intervening pavement course, a 25mm course of screenings (Grading-B) shall be spread on the prepared sub-grade before application of coarse aggregates is taken up.

c) Spreading Coarse Aggregates

The coarse aggregates shall be spread uniformly over the prepared surface in such quantities that the thickness of each compacted layer is limited to 100mm for Grading-1 and 75 - 100mm for Grading-2 and 3. The spreading shall be

done from stockpiles along the side of the roadway or directly from the vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregates nor shall hauling over permitted. The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregates as spread shall be of uniform gradation with no pockets of fine material. The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operation.

d) Rolling

Immediately following the spreading of the coarse aggregates, rolling shall be started with three wheeled power rollers of 8 to 10 tonne capacity or with tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road. Each pass of the roller shall uniformly overlap not less than one half the width of the track made in the preceding pass.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wavelike motion in the sub-grade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities found shall be corrected by loosening the surface, adding or removing necessary amount of aggregates and rerolled until the entire surface conform to the desired camber and grade. In no case shall the use of screenings be permitted to make up the depressions.

e) Application of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreader or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregates.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms or hand brooms or with both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregates.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of road which could be completed within one day's operation.

f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screenings into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued with additional screenings applied as necessary until the coarse aggregates are thoroughly keyed, well bonded and firmly set to its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or sub-grade does not get damaged due to the addition of excess quantity of water during construction.

g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water and the resulting slurry shall be swept in with hand brooms or mechanical brooms to fill the voids properly and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling the voids form a wave ahead of the wheels of the moving roller.

h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam is set. The Engineer shall have the discretion to stop hauling traffic from using the complete water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.09.00 Tack Coat

3.09.01 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.09.02 Materials

The binder used for tack coat shall be bitumen of a suitable grade as approved by the Engineer and conforming to IS-73, IS-217 or IS-454 as applicable or any other approved cutback.

3.09.03 Construction Operations

a) Preparation of Base

The surface on which the tack coat is to be applied shall be thoroughly swept and scraped clean of dust and any other extraneous materials before the application of the binder.

b) Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight run bitumen shall be 5 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers. The tack coat shall be applied just ahead of the oncoming bituminous construction.

3.10.00 Bituminous Macadam Binder Course

3.10.01 Description

This work shall consist of construction in a single course of 50mm/75mm thickness of compacted crushed aggregates premixed with a bituminous binder laid immediately after mixing on a base prepared previously in accordance with the specification and in conformity with the lines, grades and cross sections shown on the approved drawings.

3.10.02 Materials

a) Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the

Engineer complying with IS : 73.

b) Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, fairly cubical in shape and free from any disintegrated pieces, organic and other deleterious matter and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table - VIII.

Table – VIII

Physical Requirements of Aggregates For Bituminous Macadam

Sl. No.	Test	Test method	Requirements
1.	Los Angeles Abrasion Value *	IS : 2386 (Part IV)	35 percent maximum
2.	Aggregate Impact Value *	IS : 2386 (Part IV)	30 percent maximum
3.	Flakiness Index	IS : 2386 (Part I)	35 percent maximum
4.	Stripping Value	IS : 6241 (Part IV)	25 percent maximum
5.	Water Absorption	IS : 2386 (Part III)	2 percent maximum

*Aggregates may satisfy requirements of either of the two tests.

The aggregates for bituminous macadam for different thickness shall conform to Grading- A or B as given in Table-IX or X as the case may be.

Table-IX
Aggregates Grading For 75mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
63 mm	100	
50 mm	90 - 100	
40 mm	35 - 65	100
25 mm	20 - 40	70 - 100
20 mm	-	50 - 80
12.5 mm	5 - 20	-
4.75 mm	-	10 - 30
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

Table-X
Aggregates Grading For 50mm Compacted Thickness of Bituminous Macadam

Sieve Designation	Percent by weight passing the sieve	
	Grading A	Grading B
50 mm	100	
40 mm	90 - 100	
25 mm	50 - 80	100
20 mm	-	70 -100
12.5 mm	10 - 30	-
10 mm	-	35 - 60
4.75 mm	-	15 - 35
2.36 mm	-	5 - 20
75 micron	0 - 5	0 - 4

c) Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate Grading-A and B respectively unless directed otherwise by the Engineer. The quantity of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

d) Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportio ning of materials and producing a uniform mix. A variation in binder content

upto ± 0.3 percent by weight of total mix shall however be permissible for individual specimens taken for quality control tests.

3.10.03 Construction Operations

a) Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

b) Preparation of Base

The base on which the bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as shown on the drawings and as directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free of any dust and foreign matter.

c) Tack Coat

A tack coat shall be applied over the base.

d) Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix. The temperature of binder at the time of mixing shall be in the range 150 Deg. - 165 Deg. C and to that of aggregates shall be in the range 125 Deg. - 150 Deg. C provided the temperature difference between the binder and the aggregate at no time exceeds 25 Deg. C. Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly. The mixture shall be transported from the mixing plant to the point of use in a suitable vehicle. The vehicle employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

e) Spreading

After mixing, the mix shall be spread immediately by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However in restricted locations and in narrow widths where the available plants cannot operate in the opinion of the Engineer may permit manual laying of the mix. The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg. C.

In multilayer construction, the longitudinal joint in one layer shall offset into the layer below by about 150mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

f) Rolling

After spreading of mix, the rolling shall be done with 8 to 10 tonne power roller or with any other approved plant. Rolling should start as soon as the materials are spread. Rolling shall be done with care to avoid any undulation in the pavement surface.

Rolling on the longitudinal joint shall be done immediately after the paving operation. After this, the rolling shall commence at the edges and progress towards the centre longitudinally except on superelevated portions where it shall progress from the lower to the upper edge parallel to the centre line of the pavement.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface and no mix pick up on the roller wheels. The second or intermediate rolling shall follow the break down rolling as early as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh materials. The rolling shall then be continued till the entire surface has been rolled to compaction and there is no crushing of aggregates and till all the roller marks are eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking on the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rolling operation shall be completed in every respect before the temperature of the mix fall below 80 Deg. C.

Rollers shall not stand on the newly laid material as it may lead to undue deformation. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with a final surfacing without any delay. If there is to be any delay the course shall be covered by seal coat before allowing any traffic over it.

3.11.00 Open Graded Premix Carpet

3.11.01 Description

This work shall consist of laying and compacting open graded carpet of specified thickness in a single course of suitable small sized aggregates premixed with bituminous binder on a previously prepared base to form wearing course in accordance with the specification.

3.11.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as approved by the Engineer and satisfying the requirements of IS: 73, 217, 454 or any other approved cutback as applicable.

b) Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, vegetable and any other deleterious matter etc. They shall preferably be hydrophobic type. The aggregates shall satisfy the quality requirements set forth in Table-VIII except that the flakiness Index shall be limited to a maximum of 30.

c) Proportioning of Materials

The materials shall be proportioned as per the quantities given in Table-XI for 20mm thick open graded premix carpet.

Table - XI

Quantity of Materials Required For 10 Sq. M of Road Surface For 20mm Thick Open Graded Premix Carpet

Aggregates for Carpet		
i)	Stone Chippings - 12mm size ; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
ii)	Stone Chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
	Total	0. 27 Cu.m
Binder for premixing (quantities in terms of straight run bitumen)		
i)	For 0. 18 Cu.m of 12 mm size stone Chippings at 52 Kg per Cu.m	9.5 Kg
ii)	For 0.09 Cu. M of 10mm size stone Chippings at 56 Kg per Cu.m	5.1 Kg
	Total	14.6 Kg

3.11.03 Construction Operation

a) Weather and Seasonal Limitations

Open graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg. C or below.

b) Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with the drawing, specification and as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matters with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

c) Tack Coat

A tack coat complying with clause 3.09.00 shall be applied over the base preparatory to laying of the carpet. However application of tack coat shall not be necessary when the laying of carpet follows soon after laying the bituminous course.

d) Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer in boilers of suitable design avoiding local overheating and ensuring a continuous supply. The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified. The mixing of binder with chipping shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

e) Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material are laid, rolling shall be commenced with 6 to 8 tonne power rollers preferably with smooth wheel tandem type or with any other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally except on the superelevated portions where it shall progress from the lower to upper edge parallel to the centre line of the pavement.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks have been eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose. Rollers shall not stand on newly laid material as it may lead to undue deformations.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted

with a thin surface coat of approved binder before the new mix is placed against it.

f) Seal Coat

A seal coat conforming to clause 3.12.00 shall be applied to the surface immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.12.00 Seal Coat

3.12.01 Description

This work shall consist of application of a seal coat as specified for sealing the voids in the bituminous surface laid to the specified levels, grade and camber.

Type-A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type-B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

3.12.02 Materials

a) Binder

The binder shall be bitumen of suitable grade as directed by the Engineer and conforming to the requirements of IS : 73, 217 or 454 as applicable or any other approved cutback.

The quantity of binder to be adopted in terms of straight run bitumen shall be 9.8 Kg and 6.8 Kg per 10 square metre area for Type-A and Type-B seal coat respectively.

b) Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matters etc. Stone chippings shall be of 6mm size defined as 100 percent passing through 10mm sieve and retained on 2.36mm sieve. The quantity used for spreading shall be 0.09 cu.m per 10 sq.m area. The chippings shall satisfy the quality requirements spelled out in Table- VIII except that the upper limit for flakiness Index shall be 30.

c) Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.12.03 Construction Operations

a) Preparation of Base

The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat, the surface shall be cleaned free of any dust or other extraneous matters.

b) Construction of Type-A Seal Coat

The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or due to any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state shall be spread uniformly on the surface preferably by means of a mechanical grittier or otherwise manually so as to cover the surface completely. If necessary the surface shall be broomed to ensure uniform spread of chippings. Immediately after the application of the cover material, the entire surface shall be rolled with a 8 - 10 tonne smooth wheeled roller. Rolling shall commence from the edges and progress towards the centre except in superelevated portions where it shall proceed from the inner edge to the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up the irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present an uniform closed surface.

c) Construction of Type-B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder. The binder shall be heated in boilers of suitable design to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before the same are placed in the mixer. Mixing of

binder with aggregates to the specified proportions shall be continued till the latter is thoroughly coated with the former. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 6 - 8 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.12.04 Opening to Traffic

In case of Type-B Seal coat, traffic may be allowed soon after the final rolling when the premixed materials are cooled down to the surrounding temperature. However in case of Type- A seal coat, the traffic shall not be permitted until the following day.

3.13.00 Repair of Existing Water Bound Macadam Surfaces

Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated shall be repaired by removing all loose materials by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under.

Pot holes, patches and ruts shall be drained of any water and cut to regular shape with vertical sides and then be filled either with i) coarse aggregates and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer etc or with ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

3.14.00 Road Side Drains

3.14.01 Drains

The road side drains shall be made in sizes and slopes as shown on the approved drawings. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts outside the plant area as per the drawings and instructions of the Engineer.

The excavated spoils other than that required for backfilling shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for drains shall be as per the drawings. Lining of drains may be of bricks or cement concrete blocks of specified grade as shown on the approved drawing or as directed by the Engineer. If shown

on approved drawing, drains shall be of R.C.C. construction with necessary slopes.

3.15.00 Culverts

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the drawings and instructions of the Engineer after clearing the site etc. As described in the "Specification for Earthwork in Excavation and Backfilling", backfilling in layers with watering and compaction shall be done after the construction of foundations. The construction of culverts shall be done true to the lines and levels as shown on the drawings. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed as applicable.

3.16.00 Pipe Culverts and Drainage Pipes

3.16.01 Materials

The drainage pipes shall be made of R.C.C and shall be either class NP-2 or NP-3 as shown on the approved drawings. Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP4 or RDSO class for railways as shown in the drawing. All pipes shall meet the requirements of IS : 458 and shall be procured from approved manufacturers with collars as per manufacturer's specification. The tenderer shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269. Coarse Aggregates shall be as per IS:383. Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS:383.

3.16.02 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 and as per the specification given below.

a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings and as directed by the Engineer. When trenching is involved, its width on either side of the pipe shall not be less than 150mm and not more than one third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water etc as required shall be done by the Contractor.

Side slips if there be any shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done as per "Specification for Earthwork in Excavation and Backfilling" to the

satisfaction of the Engineer. The surplus spoils shall be transported and filled in low areas within the plant area as instructed by the Engineer.

When bedrock or boulder stratum is encountered during excavation, the excavation shall be taken down to at least 200mm below the bottom of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented materials, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur and shall be done as per the "Specification for Earthwork in Excavation and Backfilling". When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm. Laying of pipes shall start from the outlet and proceed towards inlet. All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care to avoid any damage. Under no circumstances the pipes shall be dropped into the trench or on supports from heights.

b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS : 783 having a projection ratio not greater than 0.70. The pipe shall be carefully laid on bedding made up of fine granular materials in an earth foundation; the bedding shall be carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height and in which the fill material is thoroughly compacted in layers not exceeding 150mm in depth around the pipe for the remainder of the pipe laid in trench.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a cradle constructed of concrete having a mix not leaner than M-15. The shape and dimension of the cradle shall be as indicated on the drawing or as directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete is set.

c) The drop walls shall be made with first class brickwork in 1:4 cement mortar.

d) The pipe culverts shall be made with proper care with respect to the invert of the pipe, gradient if any etc as specified on the drawings and as instructed by the Engineer.

e) Where R.C.C pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done upto some height for pipes to be properly laid in position and the balance height of the block shall be concreted subsequently.

f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part of cement and 2 part of clean sand with only enough water for workability. Procedure of jointing shall be as per IS : 783.

3.16.03 Relation With Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall the drainage pipes be allowed to come close to water supply pipelines.

3.17.00 Manholes and Inspection Chambers

The maximum distance between the manholes shall be 30m unless specifically permitted otherwise. In addition, at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between the manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and laid to provide a smooth flow. Connection to the existing pipelines shall be through a manhole. Manholes shall be provided with standard covers usually of C.I. or as directed by the Engineer. The cover shall be closely fitted so as to prevent gases from coming out.

4.00.00 Testing and Acceptance Criteria

All testing as mentioned in the specification and as mentioned in Clause No. 900 of the "Specification for Roads and Bridge Works, 1983" published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per the direction of the Engineer.

5.00.00 MEASUREMENT

Method of measurement shall be as per the latest version of IS:1200, Part-17 and as directed by the Engineer.

VOLUME: II B

SECTION - D
(PART I)

SUB-SECTION – D 17

FABRICATION OF STRUCTURAL STEEL WORK

Bharat Heavy Electricals Limited
Project Engineering Management
PPEI Building, Power Sector,
Plot No. 25, Sector 16A,
Noida (U.P.)-201301

C 0 N T E N T

CLAUSE NO.	DESCRIPTION	SHEET NO.
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SUB-SECTION – D XVII

FABRICATION OF STRUCTURAL STEEL WORK

1.00.00 SCOPE

This specification covers supply, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and rivets, bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the contract.

2.00.00 GENERAL

2.01.00 Work to be provided for by the Contractor

The work to be provided for by the Contractor, unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following

a) Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on the approved design drawings. As decided by the Engineer, some or all of these detailed drawings will have to be submitted for approval.

b) To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

c) To submit design calculations for joints and. connections developed by the contractor along with detailed fabrication drawings.

d) Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary rivets, bolts, nuts, washers, tie rods and welding electrodes for field connections,

e) Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

f) Suitably mark, bundle, and pack for transport all fabricated materials.

g) Prepare and furnish detailed Bill of Materials, Drawing Office Dispatch lists, Rivet and Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

h) Insure, load and transport all fabricated steelwork field connection materials to site.

i) Maintain a fully equipped workshop at site for fabrication, modification

and repairs of steelwork at site as may be required to complete the works in accordance with the Contract.

2.02.00 Work by others

No work under this specification will be provided for by any agency other than the contractor, unless specifically mentioned otherwise elsewhere in the contract.

2.03.00 Codes and standards

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard specification, any other standard practice, as may be specified by the Engineer shall be followed:

IS : 226 - Structural steel (Standard Quality)

IS : 800 - Code of Practice for general construction in steel.

IS : 806 - Code of practice for use of steel tubes in general building construction.

IS : 808 - Rolled steel beams, channels, and angle sections

IS : 813 - Scheme of symbols for welding

IS : 814 - Covered electrodes for metal arc welding of structural steel

IS : 815 - Classification and coding of covered electrodes for metal arc welding of structural steels.

IS : 816 - Code of practice for use of metal arc welding for general construction in mild steel

IS : 817 - Code of practice for training and testing metal arc welders

IS : 818 - Code of practice for safety and health requirements in electric and gas welding and cutting operations

IS : 822 - Code of practice for inspection of welds

IS : 919 - Recommendations for limits and fits for Engineering
IS : 961 - Structural Steel (High Tensile)

IS : 1148 - Rivet bars for structural purposes

IS : 1149 - High tensile rivet bars for structural purposes

IS : 1161 - Steel Tubes for structural purposes

IS : 1200 - Method of measurement of steelwork and ironwork (Part 8)

IS : 1239 - Mild Steel Tubes

IS : 1363 - Black hexagon bolts, nuts and lock nuts (dia. 6 to 30 mm) and black hexagon screws (dia 6 to 24 mm)

IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and l locknuts (dia, range 6 to 39 mm)

IS : 1367 - Technical supply conditions for threaded fasteners

IS : 1442 - Covered electrodes for the metal are welding of high tensile structural steel

IS : 1608 - Method for tensile testing of steel products other than sheet strip, wire and tube

IS : 1730 - Dimensions for steel plate, sheet, and strip for structural and general engineering purposes.

IS : 1731 - Dimensions for steel flats for structural and general engineering purposes

IS : 1852 - Rolling and cutting tolerances for hot-rolled steel products

IS : 1977 - Structural steel (ordinary quality) St-42-0

IS : 2062 - Steel for General Structural Purposes

IS : 2074 - Ready mixed paint, red oxide Zinc chromate priming

IS : 2595 - Code of Practice for Radiographic Testing

IS : 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and Steel

IS : 2633 - Method for testing uniformity of coating on Zinc Coated Articles

IS : 3757 - High strength structural bolts

IS : 4759 - Specifications for Hot-Dip Zinc Coatings on Structural Steel and other allied products

IS : 7205 - Safety Code for Erection of Structural Steelwork

IS : 7215 - Tolerances for fabrication of steel structures

IS : 7280 - Bare wire electrodes for submerged arc welding of structural steels.

IS : 9595 - Recommendations for metal arc welding of carbon and carbon manganese steels.

2.04.00 Conformity with Designs

The contractor shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum Utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.05.00 Materials to be used

2.05.01 General

All steel materials required for the work will be supplied by the contractor unless otherwise specified elsewhere in the contract. The materials shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance. All materials shall be of tested quality only unless otherwise permitted by the Engineer and/or Consultant. If desired by the Engineer, Test Certificates in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentified stocks, if permitted by the Engineer, a random sample shall be tested at an approved laboratory from each lot of 50 tones or less of any particular section.

The arc welding electrodes shall be of approved reputed manufacture and conforming to the relevant Indian Standard Codes of Practice and Specifications and shall be of heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and amperage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.05.02 Steel

All steel materials to be used in construction within the purview of this specification shall comply with any of the following Indian Standard Specifications as may be applicable:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural steel High Tensile

c) IS : 1977 - Structural steel (Ordinary quality) St-42-0

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.05.03 Rivet Steel

All rivet steel used in construction within the purview of this Specification shall comply with one of the following Indian Standard Specifications as may be applicable:

a) IS : 1148 - Rivet Bars for structural purpose

b) IS : 1149 - High tensile rivet bars for structural purposes. Where high tensile steel is specified for rivets, steps shall be taken to ensure that the rivets are so manufactured that they can be driven and heads formed satisfactorily without the physical properties of steel being impaired.

2.05.04 Electrodes

All electrodes to be used under the Contract shall be of approved reputed manufacture, low hydrogen electrode and shall comply with any of the following Indian Standard Specifications as may be applicable

a) IS : 814 - Covered electrodes for metal arc welding of structural steel

b) IS *:* 815 - Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel

c) IS : 1442 - Covered electrodes for the metal arc welding of high tensile structural steel

d) IS : 7280 - Bare wire electrodes for submerged arc welding of

structural steels

2.05.05 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard Specification IS: 1367 - Technical Supply Conditions for Threaded Fasteners.

Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable.

a) Mild Steel

All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm² and a minimum elongation of 23 per cent on a gauge length of 5.6 _/A, where "A" is the cross sectional area of the test specimen

i) IS: 1367: Technical supply conditions for threaded fasteners

ii) IS: 1608: Method for tensile testing of steel products other than sheet, strip, wire and tube

b) High Tensile Steel

The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS: 1367 or as approved by the Engineer.

2.05.06 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract:

a) IS : 2062 - Steel for general structural purposes

b) IS : 961 - Structural Steel (High Tensile Quality)

c) IS : 1977 - Structural steel (Ordinary Quality) St-42-0

d) IS : 6649 - Hardened washers

2.05.07 Paints

Paints to be used for shop coat of fabricated steel under the purview of this

contract shall conform to the Indian Standard Specification IS: 2074 - Ready mixed Paint, Red oxide Zinc Chromate Priming.

2.06.00 Coal Bin

2.06.01 Shape of bins shall be circular, polygonal, square, or rectangular in plan. Bottom hopper portion may have be conical-cum-hyperbolic or any other profile shape as shown in the drawing. Bin shall be termed as bunkers or silos according to their shape and plane of rupture of coal.

2.06.02 For general requirements, fabrication and construction details IS: 9178 (Pt.l & 11) shall be followed as general guidance. The bins shall be fabricated and erected in segments.

2.06.03 The Coal bins shall be made of mild steel plates joined together with full strength butt weld and provided with stiffeners at regular interval. Stiffeners shall be provided on the external face and it may be welded with external face.

2.06.04 Bending of plates and rolled sections to the required shape for fabrication shall be done by plate bending machine or cold bending process Without resorting to heating, hammering, angle smithy and black smithy process.

2.06.05 Poking hole (manual or pneumatic) and striking plate shall be provided to facilitate coal flow. Poking holes shall have circular MS pipe and cover cap as detailed in the drawing.

2.07.00 New Erection Marks

2.07.01 Additional structures involving new erection marks may be required to be added at any stage of work.

2.07.02 All such new erection marks shall be detailed and included in marking schemes and fabrication carded out thereafter.

2.07.03 All such new erection marks shall be considered under item of original fabrication work. As a result of additional structures becoming necessary if the work is delayed beyond the time schedule stipulated, the Engineer shall give suitable extension of time provided he is satisfied about the reasonableness of the delay involved. However, no claim for extra payments or revision of rates due to delay shall be entertained.

2.08.00 ELECTRO FORGED STEEL GRATINGS

2.08.01 Factory made fabricated electro forged gratings unit with steel conforming to IS: 2062 shall be supplied, fabricated, transported, erected and aligned in floorings, platforms, drain and trench covers, walkways, passages, staircases with edge binding strips and anti skid nosing in treads etc.

2.08.02 All grating units shall be rectangular in pattern and electro forged. The size and the spacing of the bearing bars and cross bars shall be as detailed in fabrication drawings. The contractor shall submit the grating design for different spans and load intensities along with fabrication drawings. The depth of the grating unit shall be 40 mm, unless specified otherwise.

2.08.03 The gratings shall be made up in panel units designed to coincide with the span of the structural steel framing or openings as indicated in the design/ scope drawings. Maximum possible standardization of the grating panel sizes shall be tried and designed.

2.08.04 The grating unit shall be accurately fabricated and finished, free from wraps, twists, or any defects that would impair their strength, serviceability, and appearance.

2.08.05 Grating work shall include cut outs and clearance opening for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut outs and clearances shall be treated as specified in subsequent clauses.

2.08.06 The gratings shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates, and such other components of the steel structures encountered during the placement of the gratings. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

2.08.07 Opening in gratings for pipes or ducts that are 150mm in size or diameter or larger shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

2.08.08 Penetrations in gratings that are more than 50mm but less than 150mm in size or diameter shall be welded with plates of size shown in the detailed drawings set flush with the bottom of the grating panel.

2.08.09 Unless otherwise indicated on the drawings, grating units at all penetrations shall be made up in split section, accurately fitted and neatly finished to provide for proper assembly and erection at the job site.

2.08.10 Grating units shall be provided with all necessary clips, bolts, nuts and lock washers required for proper assembly and rigid installation and fastening to abutting units supporting structural steel framing members.

2.08.11 The gratings shall be of reputed make and manufacturer, as approved by Engineer. The unit rate quoted by him for this item shall be inclusive of transport of gratings to the project site, all taxes, duties etc. He shall also provide all facilities and access to the Engineer or his representative to carry out inspection during all stages of manufacturing of gratings.

2.08.12 Maximum deviation in linear dimension from the approved dimension shall not exceed 12mm.

2.08.13 All fabricated grating section and accessories shall be blast cleaned to near white metal surface (Sa 2½) followed by either of the following two:

(a) Two coats of red lead primer and two coats of black enamel finish paint.

(b) Hot dipped galvanization at 610 gm/sq.m.

in the shop prior to erection at site, as the approved drawing.

2.08.14 Prior to finishing all surfaces shall be cleaned, free from rust, mill scale, grease, oil, or any other foreign matter by blast cleaning. BS: 4232 shall be followed for blast cleaning.

2.08.15 Primer can be applied by spray guns or by brushes, however the finish paint shall necessarily be applied by means of spray guns. The applied coatings shall be uniform, free from voids and streaks; drilled or punched holes shall be touched up prior to erection or assembly.

2.09.00 GALVANIZATION OF GRATINGS

2.09.01 Purity of Zinc to be used-for galvanizing shall be 99.5% as per IS: 2 15

2.09.02 After the shop work is complete, the structural material shall be punched with erection mark and be hot double dip galvanized. Before galvanizing the steel section shall be thoroughly blast cleaned to near white metal surface (Sa 2½).

2.09.03 The weight of the zinc coating shall be at least 610 gm/m² - unless noted otherwise.

2.09.04 The galvanized surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be cleaned and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter that is loosely attached to the steel, blistered surface, flaking or peeling off etc. The presence of any of

these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

2.09.05 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanized steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS: 2633.

2.09.06 When the steel section is removed from the galvanizing kettle, excess spelter shall be removed by 'bumping'. The processes known as 'wiping' or 'scrapping' shall not be used for this purpose.

2.09.07 Defects in certain members indicating presence of impurities in the galvanizing bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the galvanizing plant, shall render the entire, production in the relevant shift liable to rejection.

2.09.08 All structural steel shall be treated with sodium dichromate or an approved equivalent solution after galvanizing; so as to prevent white storage stains.

2.09.09 If the galvanizing of any member is damaged, the Engineer shall be shown of the extent of damage, if so directed the galvanizing may have to the redone in the similar manner as stated above at no extra cost to the Owner.

2.10.00 STAINLESS STEEL HOPPERS (As per BOQ item)

2.10.01 Material

In case SS Hopper is to be fabricated & erected as per BOQ item with SS415M, following specification shall be followed.
Stainless steel hopper of grade SS 415M as manufactured by SAIL or equivalent shall be provided in the lower portion of bunker hopper. SS 4 15M having the following chemical composition shall be used.

Material	%	Remarks
Carbon	10.03%	Max.
Silicon	1.60%	Max.
Manganese	0.80% to 1.50%	
Phosphorous	0.03%	Max.
Sulpher	0.03%	Max.
Chromium	10.80% to 12.50%	

Nickel	1.50%	Max.
Titanium	0.75%	Max.
Nitrogen	0.03%	Max.

The mechanical properties shall be as follows:

Description	**Value**	**Remarks**
Hardness Rock Well B Scale	90	Max.
Tensile Strength	450 MPa	Min.
Yield Strength	300 MPa	Min.
Elongation	25%	Min.

2.10.02 Fabrication

The fabrication, erection, alignment and welding shall be carried out as per the accepted practice and in accordance with relevant I.S. and international specification as well as stipulations contained herein. Fabrication drawings shall be prepared by the contractor on the basis of the design / scope drawings furnished by Engineer. The fabrication and erection works shall be done as per the approved fabrication drawings.

2.10.03 Fabrication Drawings

a) Fabrication drawing shall give the cutting plan for each hopper plate. Such, cutting plan shall be based on the size of the Stainless Steel plate available at store. In order to reduce the wastage and ensure the maximum utilization of stainless steel plate, the cutting plan shall take in the consideration of the reverse curvature and place the various elements of hopper plate in opposite fashion to reduce the end wastage. Similarly the hopper plate element having different radii shall be placed one inside the other, to optimize the stainless steel plate use. Such optimization may also required adjustment in the size of the each element of hopper plate and also additional weld joints.

b) The bill of material of hopper plate shall indicate the inner surface area of the hopper, weight of the hopper based on the inner surface area, weight of each of the cut plate of hopper fabrication, weight of cut and scrap pieces generated. Contractor shall return to the Owner's store all unutilized (surplus) stainless steel plates and all waste and cut pieces generated. Non return of any part of the surplus/waste steel pieces to the Owner's store will call for the penal recovery at three (03) times the maximum

procurement rate for the weight of stainless steel pieces not returned to the store.

c) In case the contractor does the cutting of the stainless steel without approved cutting plan then all the wastage (i.e. the difference between the weight of stainless steel plate cuts and the actual finished weight considered for the measurement for payment) shall be subjected to the penal recovery at the rate mentioned above.

2.10.04 Cuffing

Cutting may be affected by shearing, or by using plasma. The cut edges of all plates shall be perfectly straight and uniform through out. Cutting shall be done as per the cutting plan shown in the fabrication drawing. Should the Engineer find it necessary, the edges shall be ground smooth afterwards by contractor within the unit rates quoted by him. All the edge s shall be ground smooth before they are welded.

2.10.05 Jointing

Welding shall join stainless steel. All weld joints (along the inclined plane) shall be staggered. Any common welding process can weld stainless steel viz. MIG, metal arc or plasma using the covered compatible electrodes as per IS: 5206 or by inert gas arc welding as per IS: 2811. Shielding gas shall be Argon + Hydrogen mixture or Argon + Oxygen mixture. However, Argon + Oxygen mixture shall be preferred. Carbon-di-oxide mixture shall be avoided. 308L and 315L electrodes/fillers shall be used for the welding of Stainless Steel to Stainless Steel and Stainless Steel to Mild Steel respectively. However, the welding process and the type of the electrodes to be used for welding shall be as per welding procedure, as approved by the Engineer. On the basis of the welding procedure, the Contractor shall conduct qualification test.

2.10.06 Bending

The stainless steel plates shall be subjected to cold forming and bending in order to get the desired shape and profile.

2.10.07 Welding sequence

The type of electrodes, welding sequence, preheat and interpass temperature and post weld heat treatment shall be as approved by the Engineer.

2.10.08 Acceptance Criteria of Fabricated Structures

The acceptance of the fabricated structure work shall depend upon correct dimensions and alignment, absence of distortion in the structure, satisfactory results from the inspection and testing of the welded structure joints and the

test specimens, general workmanship being good meeting the tolerance requirements given in IS: 7215.

2.11.00 BEARINGS

2.11.01 PTFE (Poly tetra fluorethylene) slide bearing

a) General

The bearings shall consist of upper and lower units. The upper unit shall include a sole plate with mirror finish stainless steel facing bonded to the bottom surface of the sole plate. The lower unit shall consist of a relevant laminated elastomers pad surfaced with PTFE. A rigid confining medium substructure bonds the PTFE to the pad. When the upper and lower units are mated the stainless steel slides on the PTFE surface with an extremely low coefficient of friction. These bearings shall be designed as per the performance requirements. The bearing shall be of reputed make and manufacturer as approved by Engineer, for required vertical loads, as per the construction drawings and for a maximum displacement of ± 50 mm.

b) Material

PTFE bearing shall be sliding against highly polished stainless steel and the coefficient of friction between them shall be less than 0.06 at 55 kg/cm². In order to prevent cold flow in the PTFE surface it shall be rigidly bonded by a special high temperature resistant adhesive to the stainless steel sub-strata. The stainless steel surface, which slides against the PTFE, is mirror polished. The stainless steel shall be bonded to the top plate by special high strength adhesive. The thickness of the stainless steel shall be between 1.0 to 1.5mm.

The resilient bearing pad shall consist of multiple layers of lightweight fabric impregnated with a high quality elastomer compound vulcanized into slabs of uniform standard thickness as per the requirement. This shall withstand vertical (compressive) load not less than 500 kg/cm² and shear loads upto 40 kg/cm².

c) Installation

The seating area for PTFE bearing shall be prepared accurately level and furnished with a thin layer of epoxy resin mortar. The bearing will be placed on this layer while it is still workable and the bearing is levelled. The bearing should not be displaced as the beam is lowered into position. When the mortar and adhesive are fully set and the beam slightly above the top of the bearing. The upper surface of the bearing shall then be coated with sufficient thickness of epoxy resin mortar so that when the beam is lowered on to the temporary supports it comes into full contact

with the mortar and some is squeezed out. The surplus shall be troweled off and after the mortar is fully set the temporary supports removed.

2.12.00 Storage of material

2.12.01 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged, shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed and the cost incurred thereof shall be realised from the Contractor. The Contractor shall maintain upto date accounts in respect of receipt, use, and balance of all sizes and sections of steel and other materials. In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.12.02 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section wise and lengthwise so that they can be easily inspected, measured, and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.12.03 Electrodes

The electrodes for electric arc welding shall be stored in properly designed racks, separating different types of electrodes in distinctly marked compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.12.04 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length, and quality.

2.12.05 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.13.00 Quality Control

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing free of cost all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work

a) Steel: Quality manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.

b) Rivets, Bolts, Nuts & Washers : Manufacturer's certificate, dimension checks, material testing.

c) Electrodes : Manufacturer's certificate, thickness and quality of flux coating.

d) Welders : Qualifying Tests

e) Welding sets : Performance Tests

f) Welds : Inspection, X-ray, Ultrasonic tests

g) Paints : Manufacturer's certificate, physical inspection reports

h) Galvanizing : Tests in accordance with IS 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 - Specification for Hot-Dip Zinc coatings on Structural Steel and other allied products.

2.14.00 Standard dimensions, forms and weights

The dimensions, forms, weights and tolerances of all rolled shapes rivets, bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.15.00 Fabrication Drawings

The contractor shall within thirty (30) days after the award of the Contract submit to the Engineer the Schedule of Fabrication and erection of structural Steelworks, for approval. Within one week after receipt of approval on design of any steel structure (part or full) based on the approved design. As decided by the Engineer, six (6) copies each of some or all of the detailed fabrication drawings will have to be submitted for approval.

The sequence of preparation of fabrication drawings shall match with the approved fabrication and erection schedule. The above-mentioned approval for fabrication drawings will be accorded only towards the general conformity with the design requirements as well as specifications. The approval of drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The fabrication drawings shall include but not limited to the following:

a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

b) Dimensional drawings of base plates, foundation bolts location etc.

c) Comparison sheets to show that the proposed alternative section, if any, is as strong as the original sections shown on the Design Drawings.

d) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

e) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

These drawings shall give all the necessary information for the fabrication, erection, and painting of the steelwork in accordance with the provisions of this Specification. Fabrication drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Fabrication drawings shall give complete information necessary for fabrication of the various components of the steelwork,

including the location, type, size, and extent of welds. These shall also clearly distinguish between shop and field rivets, bolts, and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately. Notes on the fabrication drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked up stresses and distortion. Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification. IS: 813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall carry out at his cost any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.00.00 WORKMANSHIP

3.01.00 Fabrication

3.01.01 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS: 800 - Code of Practice for general construction in steel and other relevant Indian Standards or equivalent.

3.01.02 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification on IS: 1552 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600°C.

3.01.03 Cutting

Shearing, cropping, or sawing shall affect cutting. Use of a mechanically controlled gas-cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges, occasional notches or gouges not more than 4 mm deep will be permitted. Gouges greater than 4 mm that remain from cutting shall be removed by grinding. All re-entrant corners shall be shaped notch free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.01.04 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required, unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand-flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.01.05 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams web shall be not more than 3 mm at each end, but where for practical reasons greater clearance is necessary, suitably designed cheatings shall be provided.

3.02.00 Riveted and bolted construction

3.02.01 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of rivet or bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the rivet or bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the rivet or black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of BS as specified in IS: 919. Parts to be connected shall be firmly held together by

tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for rivets or bolts shall not be formed by gas cutting process.

3.02.02 Assembly

All parts of riveted members shall be well pinned or bolted and rigidly held together while riveting. Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the rivets or bolts shall be reamed. Poor matching of holes shall be cause for rejection .The component parts shall be so assembled that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Rivets shall ordinarily be hot driven, in which case their finished heads shall be approximately hemispherical in shape and shall be of uniform size throughout the work for rivets of the same size full, neatly finished and concentric with he holes. Rivets shall be heated uniformly to a temperature not exceeding 1 125°C they shall not be driven after their temperature has fallen below 540°C.

Rivets shall be driven by power riveters, of either compression or manually operated type, employing pneumatic, hydraulic or electric power. Hand driven rivets shall not be allowed unless in exceptional cases specifically approved by the Engineer. After driving, rivets shall be tight, shall completely fill the holes and their heads shall be in full contact with the surface. In case of countersunk rivets, the countersinking shall be fully filled by the rivet, any proudness of the countersunk head being dressed off flush, if required.

Riveted members shall have all parts firmly drawn and held together before and during riveting and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

All loose, burnt, or otherwise defective rivets shall be cut out and replaced and special care shall be taken to inspect all single riveted connections. Special care shall also be taken in heating and driving long rivets. The Contractor shall prove the quality of riveting by cutting some rivets chosen at random by the Engineer. No extra payment will be made to the Contractor for such cutting and replacing. Riveting work, for any particular section or group, will be considered satisfactory when at least 90% of the corresponding cut rivets is found to be sound. If the ratio is below 75%, all the rivets in the particular section or group shall be cut, removed and replaced and tested again at the

Contractor's expense. For cases between 75% and 90% the engineer shall have the option to instruct cutting and replacing any number of further rivets at the Contractor's cost as he deems necessary.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if shown on drawing or directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project trough the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer one spring washer or lock nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.03.00 Welded Construction

3.03.01 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS: 817.

3.03.02 Preparation of material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint, and any other foreign material except that mill scale, which withstands vigorous wire brushing, may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas cutting shall, wherever practicable, be done by a mechanically guided torch.

3.03.03 Assembling

Parts to be fillet welded shall be brought in, as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet welds shall be increased by the amount of the separation. The fit of joints at contact surfaces, which are not completely sealed by, welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2°).

The work shall be positioned for flat welding whenever practicable.

3.03.04 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shod splicing not more than three sub-sections, each made in accordance with this paragraph.

When required by the Engineer, welded assemblies shall be stress relieved by heat-treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.03.05 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 m thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross-section. Groove welds made with the use of the backing of the same material, as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the contract.
To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.03. 12 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5°C. However, if welding is to undertaken at low temperature, adequate precautions as recommended in relevant Indian Standard shall be taken. When

the parent material is less than 40 mm thick and the temperature is between (-) 5°C and 0°C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is hand warm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20°C. All requirements regarding preheating of the parent material shall be in accordance with the relevant Indian Standard.

3.03. 13 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool, peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.03. 14 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.04.00 Finish

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.1 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc; after welding/riveting together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles of channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm.

3.05.00 Slab bases and caps

Bases and caps fabricated out of steel slabs, except when cut material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face, which is to be grouted direct to a foundation, need not be machined if such face is true and parallel to the upper face.

To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3. 12.00 Lacing bars

The ends of lacing bars shall be neat and free from burns.

3. 13.00 Separators

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.14.00 Bearing Plates

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.15.00 Floor Grating

All grating units shall be rectangular in pattern and of pressure locked assembly. The size and spacing of bearing bars and cross bars shall be as approved in detailed drawings. Alternatively diamond pattern grating if approved may be used.

The grating shall be made in panel units designed to span as indicated in structural steel framing drawing or as directed by the Engineer.

The grating units shall be finished free from warps, twists, or any other defects. Grating work shall include cutouts and clearance openings for all columns, pipes, ducts, conduits etc. The gratings shall be notched, trimmed, and neatly finished around components of the steel structures encountered. Binding strip shall be provided on the grating to suit the profile. Openings in gratings shall be provided with steel bar toe plates of not less than 5 mm thickness and 100 mm width.

Unless otherwise indicated on drawings, all penetrations of grating units shall be made up in split section, accurately fitted, and neatly finished. Grating units shall be provided with all necessary clips, bolts, lock washers etc. for proper assembly and installation on supporting steel members. Maximum deviation in linear dimension shall not exceed 12 mm.

3.10.00 Chequered Plates

Minimum thickness of chequered plate floorings, covers etc. shall be 6 mm O/P. Chequered plate shall be accurately cut to the required sizes and shapes and the cut edges properly ground. Stiffeners shall be provided wherever required from design consideration.

3.11.00 Architectural Clearances

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.11.00 Shop connections

a) All shop connections shall be otherwise riveted or welded as specified on the Drawings.

b) Heads of rivets on surfaces carrying brick walls shall be flattened to 10 mm thick projection.

c) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the contractor will have to make the desired changes at no extra cost to the exchequer.

3.13.00 Castings

Steel castings shall be annealed.

3.14.00 Shop erection

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before dispatch. The parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.

3.15.00 Shop painting

3.15.01 General

Unless otherwise specified, steelwork, which will be concealed by interior building finish, need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other methods of loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by the solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by trough sweeping with a fibre brush.

3.15.02 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, Positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.15.03 Contact surfaces

Contact surface shall be cleaned in accordance with sub-clause 3.13.1 before assembly.

3.15.04 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.15.05 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.16.00 Galvanizing

3.16.01 General

Structural steelwork for switchyard or other structures as may be specified in the contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS: 2629 - Recommended practice for Hot-Dip Galvanizing of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.16.02 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature. The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.16.03 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS: 4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after leaving been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport, handling, and

erection. Damages, if occur, shall be made good in accordance or as directed by the Engineer.

4.00.00 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.01.00 Inspection

Unless specified otherwise, inspection to all, work shall be made by the or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide free of charge, such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract. The Contractor shall guarantee compliance with the provisions of this Specification.

4.02.00 Testing and Acceptance Criteria

4.02.01 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own Cost. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.02.02 Steel

All steel supplied by, the Contractor shall conform, to the relevant Indian Standards. Except otherwise mentioned in the contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T or less of any particular section for tests to conform to relevant Indian Standards. Cost of all tests shall be born by the contractor.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, fittings, rusts etc. that may impair their strength, durability, and appearance.

4.02.02 Welding

a) The weld surface shall be cleaned with steel wire brush to remove spatter metal, slag etc. and 100% of welds shall be inspected visually for size, length of weldment and external defects. Weld gauges shall be used for checking weld sizes. The surface shall be clean with regular beads and free from slags, cracks, blow-holes etc.

b) Non-destructive examination shall be carried out to determine soundness of weldments as follows:

i) 10% at random on fillet-joints.

ii) 100% on all butt-joints.

c) Should the ND tests indicate defects like improper root penetration, extensive blowholes, slag intrusion etc., such welds shall be back gauged, joints prepared again and rewelded. All defects shall be rectified by the Contractor at no extra costs.

d) All electrodes shall be procured from approved reputed manufacturers with test certificates. The correct grade and size of electrode, which has not deteriorated in storage, shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tones of welded fabrication, the Engineer may ask for 1(one) test-destructive or non-destructive including X -ray, ultrasonic test or similar, the cost of which shall be borne by the Contractor.

4.02.04 Rivets, bolts, nuts and washers

All rivets, bolts, nuts, and washers shall be procured from M/s. Guest Keen William Ltd. or equivalent and shall confirm to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards. Cost of all such testing shall have to be borne by the Contractor. In addition to testing the rivets by hammer, 2% (two per cent) of the rivets done shall have to be cut off by chisels to ascertain the fit, quality of material and workmanship. The removal of the cut rivets and re-installing new rivets shall be done by the Contractor at his own cost.

4.02.05 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.02. 12 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS: 2633 - Method for testing uniformity of coating on Zinc Coated Articles and 15: 4759 - specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.03.00 Tolerance

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS: 1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures shall be as specified in IS: 721 - Tolerances for Fabrication of Steel Structures.

4.04.00 Acceptance

Should any structure or part of a structure be found not to comply with any of the provisions of this specification, the same shall be liable to rejection. No Structure or part of the structure once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check some of the tests at an appropriate laboratory at the contractors cost.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue acceptance certificate, upon receipt of which, the items will be shop painted, packed and dispatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.05.00 Delivery of materials

4.05.01 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work. The Owner may prescribe or control the sequence of delivery of materials, at his own discretion.

4.05.02 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.05.03 Shipping

Shipping shall be strictly in accordance with the sequence stipulated in the agreed Programme. Contractor shall dispatch the materials to the e worksite securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:

a) Name and address of the consignee

b) Name and address of the consignor

c) Gross weight of the package in tonnes and its dimensions

d) Identification marks and/or number of the package

e) Custom registration number, if required

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially -

a) Name of the Contractor

b) Number and date of the Contract

c) Name of the office placing the contract

d) Nomenclature of stores

e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each packing shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor at no additional cost to the Owner. When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above-mentioned charges, the amount paid will be deducted from the bills of the Contractor.

Necessary advise regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.00.00 INFORMATION TO BE SUBMITTED

5.01.00 With Tender

The following information is required to be submitted with the Tender:

a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

i) Preparation and approval of fabrication drawing

ii) Procurement of Materials

iii) Fabrication and shipping of all anchor bolts

iv) Fabrication and shipping of main steelwork.

v) Fabrication and shipping of steelwork for bunkers, tanks and/or silos

as applicable.

vi) Fabrication and shipping of all other remaining steelwork including miscellaneous steelwork.

vii) Final date of completion of all shipments.

b) Shop

Location of the Tenderer's fabrication workshop giving details of equipment, manpower, the total capacity, and the capacity that will be available exclusively for this contract shall be submitted.

5.02.00 After Award

After award of the Contract the successful Tenderer is to submit the following:

a) Complete fabrication drawings, material lists, cutting lists, rive and bolt lists, field welding schedules based on the approved design drawings prepared by him in accordance with the approved schedule.

b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day o. each month, giving the up-to-date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

c) Detailed monthly material reconciliation statements relevant to the Work done and reported in the Progress Report, giving the stock at hand of raw steel, work in progress, finished materials.

d) Results of any test as and when conducted and as require by the engineer.

e) Manufacturer's mill test report in respect of steel materials, rivets, bolts, nuts, and electrodes as may be applicable.

6.00.00 RATES AND MEASUREMENT

6.01.00 Rates

6.01.01 The items of work in the Schedule of items describe the work in brief. The various items of the Schedule of items shall be read in conjunction with these specifications including amendments and additions, general conditions of contract, special conditions of contracts, and other tender documents, if any. For each item of Schedule of Items, the bidder's rates shall include the activities covered in the description of the item as well as all necessary

operations described in the Specifications.

6.01.02 The bidder's rates shall include cost of all minor details which are obviously and fairly intended and which may not have been included in the description in these documents but are essential for the satisfactory completion of the work. Rates shall also include for taking all safety measures.

6.01.03 The bidder's -rates for all items of schedule of items shall include complete cost towards plant, equipment, erection and dismantling of scaffolding, men, materials and consumables, skilled and unskilled labour, levies, taxes, royalties, duties, transport, storage, repair/rectification/maintenance until handing over, contingencies, overhead and all incidental items not specifically mentioned but reasonably implied and necessary to complete the work.

6.01.04 No claims shall be entertained, if the details shown on the `Released for Construction' drawings differ from those shown on the bid/tender drawings.

6.01.05 Rates shall be inclusive of all leads and lifts/elevation.

6.01.06 The bidder's rates for Structural Steel shall include for fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, erection scheme, alignment, welding, including preheating and post heating, testing of welders, inspection of welds, visual inspection, non destructive and special testing, rectification and correction of defective welding works, production test plate, inspection and testing, erection scheme, protection against damage in transit, stability of structures, etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus/waste steel materials including cut pieces/waste steel, provision of additional butt/weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

The rates for fabrication are inclusive of all tests on welds and material and no extra shall be payable for quality tests specified for fabrication of structure in shop or at site.

Separate BOQ items for test on welds like radiography or Ultrasonic, DPT, magnetic particle tests are kept for tests on material/fabrication not covered under regular fabrication item of BOQ.

6.01.07 The bidder's rates for foundation bolts assembly shall include fabrication, threading, heat treatment, erection, installation, and alignment of complete bolt assembly with nuts, locknuts, anchor plates, stiffener plates, protective tape, etc. This shall also include the cost of all materials not issued by the Owner. Material issued by Owner will be specified in GCC.

6.01.08 The bidders rates for application of inorganic primer shall include surface preparation to near white metal surface by blast cleaning, abrasives, touch up painting, suitable enclosure to avoid contamination and the necessary statutory approval from the factory inspector/pollution control board etc. regarding the method of blast cleaning and abrasives used, and getting approval of the specialized agency supplying the primer specified.

6.01.09 The bidder's rates for application of finish painting system shall include surface preparation, application of intermediate (under) coat, finish coat and final finish coat, and getting approval of the specialized agency supplying the finish paint.

6.01.10 The bidder's rates for electro-forged gratings (if specified) shall include supply, fabrication, transportation to the site, erection and alignment of factory made electro-forged gratings, all taxes, duties thereon etc. The rates shall also include preparation of grating design for different spans and load intensifies, preparation of design and fabrication drawings, edge preparation, blast cleaning followed by finish paint.

6.01.11 The bidder's rates for galvanization of factory made electro-forged gratings (if specified) shall include the application of hot dipped galvanization as finish over the fabricated gratings and the treatment to be given for prevention of white storage stains, as per the technical Aspiration.

6.01.12 The bidder’s rates for permanent mild steel bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types of Structural Steel works, as per the technical specification.

6.01.13 The bidder’s rates for high strength structural bolts, nuts and washers shall include the supply and fixing of such bolts, nuts and washers in position, for various types, of Structural Steel works, as per the technical specification.

6.01.14 The bidder’s rates for dismantling, additions to, alterations in and/or modifications shall be inclusive of all operations such as lowering of material, carriage etc., as mentioned in the technical specification. Unutilised steel pieces cut/removed shall be returned to the project stores free of charge. Non-return of unublized steel pieces to the Owner's store would be considered as wastage and recovery would be affected as per the provision of contract for structural steel consumption. This shall not include the weight of temporarily dismantled/supported members, connected member.

The bidder should prepare an optimised cutting plan as per fabrication drawing to utilise the steel material upto maximum extent and minimise the wastage/scrap. Quantity of wastage/scrap of material should be limited to the percentage mentioned elsewhere in the conditions of tender/ contract specifications.

6.01.15 The bidder's rates for re-erection of erection marks after additions to, alterations in and/or modifications shall be inclusive of all operations mentioned in technical specification for the calculated weight of the rectified/modified erection mark rejected at site. This shall not include the weight of temporarily dismantled/supported members, connected member. All the operations mentioned above for restoring such members shall be carried out at no extra cost. The work of erection of any erection mark which has not been dismantled but have been modified/rectified before erection shall not be paid under this item but shall be paid under relevant item of fabrication and erection of steel work of Schedule of items for the modified weight.

6.01.16 The bidder's rates for PTFE shall include design, supply, transportation of the complete assembly with guides and dust protection cover and installation of bearings in position drilling, bolting, erecting aligning etc. along with any taxes, duties thereon etc.

6.01.17 The bidder's rates for Stainless Steel hopper (if specified) shall include fabrication and erection, transportation to site, preparation checking collecting and distributing of the fabrication drawings and design calculations, all other operations mentioned in the technical specification. The rates shall also include for erection scheme, alignment, making cutting plan, cutting, jointing, bending, rolling, grinding, drilling, bolting, assembly, edge preparation, welding including pre-heating, post-heating, testing of welders, inspection of welds, inspection and testing, protection against damage in transit, stability of structures, installation of temporary structures etc. The rates shall also be inclusive of providing and installing temporary structures, transport of Owner issue material from store, return of surplus / waste steel materials including cut pieces/waste steel, provision of additional butt / weld joint to reduce the wastage and all other general, special, such requirements as may be required, for the successful completion of the work.

6.01.18 The bidders rates for preformed flexible open ended bellow strap of neoprene (if specified) shall include supply and transportation, installation in position, drilling, bolting, aligning etc. complete along with any taxes, duties thereon etc.

6.01.19 The bidder's rates for Stainless Steel Hand Rail (if specified) shall include complete Hand Rail including, materials, fabrication, grinding & finishing, stainless steel beading, stainless steel cleats, stainless steel fasteners, neoprene gaskets, preparation of shop drawing but excluding the cost of glazing. The Owner shall supply no material for this item of work.

6.02.00 MODE OF MEASUREMENT

6.02.01 The measurement for the item of foundation bolts assembly including that of nuts; locknuts shall be based on the calculated weight of steel installed in Metric Tonne, corrected to second place of decimal. The weight of the

foundation bolt shall be calculated in the same way as that done for the item of fabrication, erection, alignment of structural steel. The weight of the nut / locknut shall be taken as per actual weight supplied by the contractor and accepted by the Engineer.

6.02.02 The measurement for the item of fabrication, erection, alignment, welding, etc. of structural steel work shall be based on the approved weight of steel nearest to a Kg, by applying the unit weight as adopted at the time of issue of structural steel on the measurements worked out as given below.

6.02.03 For ISMB, ISMC, ISA, flats, round bars, square bars and pipes, length shall be taken as per distance between planes normal to the axis of the member passing through the extreme points of the section.

6.02.04 Gussets plates in trusses, and bracings, brackets plates, stiffeners, and skew cuts if any in plates for butt welds, the area shall be assumed as the minimum circumscribed rectangle. However deduction for any notch/skew cut shall be made as mentioned in clause no-6.02.06.

6.02.05 For bunker wall plates, the minimum-circumscribing rectangle of the individual plate/pieces out of which these wall plates are assembled by butt-welding, shall be measured. Care shall be taken to ensure maximum utilization of cut-pieces generated by providing extra butt joints (for which no extra payment shall be made).

6.02.06 For all other plates, where the area of any notch/skew cut in the plate is less than 0.05 sq.m. the area of the plate shall be assumed as that of the minimum circumscribing rectangle for the purpose of measurement and calculation of area for the purpose of payment. However, if the area of any notch/skew cuts in a plate is more than 0.05 sq.m, the area of notch/skew cut shall be deducted from assumed minimum circumscribing rectangular area for the purpose of payment.

6.02.07 No deduction shall be made for the hole in the members, if the area of individual hole is less than 0.05 sq.m. The weight shall be calculated by deducting the area of holes, if area of individual hole is more than 0.05 sq.m.

6.02.08 All cut-pieces and scrap generated due to cutting of holes, skew-cuts of plates, gussets, brackets, stiffeners, etc. shall be stacked separately and handed over to the project stores without being considered for material accounting as the circumscribing rectangle has been considered for payment.

6.02.09 The splice plate shown in the fabrication drawing or approved by the Engineer shall only be measured for payment.

6.02.10 The weight of permanent bolts, washers and nuts and welds shall not be included in the weights of the members. No extra payment shall be made for

welding/bolting.

6.02.11 The bolts and nuts required for erection purpose shall not be paid for and may be taken away by the Contractor after final welding for members. Erection boltholes left after removal of erection bolts shall be suitably plugged with welds.

6.02.12 The measurement for the item of application of inorganic primer including blast cleaning of steel surfaces shall be based on the weight on which the zinc silicate primer is applied, after blast cleaning in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.13 The measurement for the item of application of finish primer system shall be based on the weight on which the epoxy based finish primer is applied in Metric Tonne, corrected to third place of decimal. The weight shall be the weight as approved, for erection mark/element of the mark painted, for payment of the item of fabrication and erection of structural steel works.

6.02.14 The measurement for the item of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor, and accepted by the Engineer. Nothing extra shall be payable for making cutouts, notches, openings of any profile, trimming profiles etc. in the grating units.

6.02.15 The measurement for the item of hot dipped galvanization of gratings shall be based on the actual weight in Kgs, corrected to second place of decimal of gratings galvanized by the Contractor and accepted by the Engineer.

6.02.16 The measurement for the item of permanent bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.17 The measurement for the item of High Strength Structural bolts with nuts and washers shall be based on the actual weight in Kgs, corrected to second place of decimal, as supplied by the Contractor and accepted by the Engineer, and as per the approved bolts and nuts schedules.

6.02.18 The measurement for the item of the work of dismantling, additions, alterations, reerection etc. shall be as given below

6.02.19 For dismantling, the unmodified weight of the actually dismantled erection marks shall only be measured.

6.02.20 For the work of addition to, alteration in and / or modification of 'erection

marks' either in erected position or in the fabrication yard, measurement of weight for payment purpose shall be calculated as the arithmetic sum of weight of steel cut and removed from the erection mark, weight of steel reutilised out of such cut and removed pieces and weight of additional new steel pieces added to the erection mark.

6.02.21 For re-erection the weight of the modified erection mark shall only be measured.

6.02.22 The weight shall be measured nearest to kg. and shall be arrived in a manner similar to the measurement for the item of fabrication, erection, alignment and welding of structural steel.

6.02.23 The measurement for the item of PTFE bearings shall be based on the load carrying capacity of PTFE in MT, corrected to third place of decimal, supplied by the contractor and as accepted by the Engineer and as per the approved bearing schedule, for the total vertical load carrying capacity, for all bearings.

6.02.24 The measurement for the item of stainless steel hopper shall be based on the actual finished weight of hopper weight in Kgs, corrected to second place of decimal. The hopper weight shall be arrived by multiplying of the inner surface area of the hopper with the unit weight of the hopper plate.

6.02.25 The measurement for the item of flexible open-ended bellows straps of neoprene shall be based in running meter, corrected to second place of decimal. Bellow Straps shall be supplied as per the requirement of the approved drawings. The measurement shall be done for the inner circumference of the bunker on which neoprene has been fixed and for the length supplied by the Contractor 'and as accepted by the Engineer.

6.02.26 The measurement for the item of Stainless Steel Hand Railing shall be based on finished weight of handrail in Kgs corrected to second place of decimal. The weight shall also include the weight of Stainless Steel fasteners, Stainless Steel beading, Stainless Steel cleats etc. The weight shall be the finished weight of Hand Rail, as accepted by the Engineer.

TECHNICAL SPECIFICATION

FOR LABOUR COLONY

Bharat Heavy Electricals Limited

Project Management Department

Power Sector – Southern Region

690, Anna Salai, Nandanam

Chennai – 600 035

1 BROAD DESCRIPTION OF WORK

Providing labour colony is in the scope of the bidder. The labour colony area is divided in to various blocks and Bidder shall be allotted the blocks according to the size of the man power planned for mobilisation of the awarded work. The following are the broad description of the labour facilities to be provided by the bidder.

1. Pre-Fabricated shed of Standard size of 40m x 11 m consisting 10 Nos of rooms sizing 4mx4m each as per the specification/drawing No. BHEL/PSSR/CVL/LABCOL/03, Rev-00. Bidder may alter size of the shed according to the size of the manpower.
2. Toilet blocks, each sizing 1.5m x 1.5m as per the specification/drawing No. BHEL/PSSR/CVL/LABCOL/02, Rev-00
3. Washing Area & Bathing Area as per the specification/drawing No. BHEL/PSSR/CVL/LABCOL/02, Rev-00
4. Cooking cum Dining Area as per the specification/drawing No. BHEL/PSSR/CVL/LABCOL/02, Rev-00

2 FACILITIES PRVIDED BY BHEL

A. Land for labour colony shall be allotted by BHEL

B. BHEL shall provide water at one point in the Plant Premises. Further tapping the water from for the labour colony shall be under the scope of the bidder.
In case of non-availability of water, the contractor shall make his own arrangements of water suitable for labours at their own cost. No separate payment shall be made for any contingency arrangement made by contractor, due to delay / failure for providing water supply.

C. Power will be provided to the contractor free of cost at one single point within the labour colony area. The contractor shall make his own arrangement for further distribution with necessary isolator/LCB etc. Necessary “Capacitor Banks” to improve the Power factor to a minimum of 0.9 shall be provided by the contractor at his cost.

Penalty if any levied by customer on this account will be recovered from contractor's bills. Any duty, deposit involved in getting the Electricity shall be borne by the bidder. Provision for distribution of electrical power from the given single central common point to the required places with proper distribution boards, approved cables and cable laying including supply of all materials like cables, switch boards, pipes etc., observing the safety rules laid down by electrical authority of the State / BHEL / their customer with appropriate statutory requirements shall be the responsibility of the tenderer / contractor. BHEL is not responsible for any loss or damage to the contractor's equipment as a result of variations in voltage / frequency or interruptions in power supply. As there are bound to be interruptions in regular power supply, power cut/ load shedding in any construction sites, contractor should make his own arrangement for alternative source of power supply through deployment of adequate number of DG sets at their cost during the power breakdown / failure to get urgent and important work to go on without interruptions. No separate payment shall be made for this contingency.

D. Bidder shall provide toilet blocks with necessary septic tanks and soak pits as mentioned in the layout drawing. Bidder shall be responsible for clearing the septic tank at regular intervals.

E. Main Roads and Drains shall be constructed by BHEL, further interconnection to main road and drain shall be done by the vendor.

F. Lighting in the roads shall be provided by BHEL, further lighting within the areas allocated to the Bidders shall be taken up by the bidder. The bidder shall provide suitable lighting in their areas.

G. The layout, specification including dimensions of the facilities of the labour colony as provided in the bid drawings shall be strictly followed.

3.0 FACILITIES TO BE PRVIDED BY BIDDER

3.1.1.1 Labour sheds as per the layout, specification shall be provided by the bidder as per the bid drawing including foundations.

3.1.1.2 Toilet, Bath and wash area shall be provided as per the layout and specification provided in the bid drawing including foundations.

3.1.1.3 Kitchen cum dining room as per the layout, specification shall be provided by the bidder as per the bid drawing including foundations.

3.1.1.4 Electrification all the rooms and the Utility areas like toilet, bath area and kitchen.

3.1.1.5 Minimum 2 Nos. of ceiling fans shall be provided per room of the labour shed.

3.1.1.6 Paving shall be provided around labour sheds to avoid stagnation of rain water.

3.1.1.7 The specification/ drawings for the labour shed, attached herewith, are typical arrangements. However, allocation of land, number of sheds and number of rooms in a shed shall be as per the requirement of workmen to be deployed for the scope of work mentioned in the contract in adherence to the schedule of work and meeting to HSE norms of BHEL.

4.0 SPECIFICATION FOR THE LABOUR SHED

4.1 MAIN STRUCTURE & WALLS:

- The Structural walls shall be made out of tubular sections. 50mm thick AEROCON panels or equivalent for walls using 1mm thick GI channels, Colour Coated Sheet roof Supported with steel columns, Trusses & Purlins Inclusive of MS Door frames with flush shutters of Size 3’ X 7’ X 20 Rooms. MS Window frames with 4mm thick Plain glass of Size 4’ X 4’ X 20 No’s, Painting.

4.2 WALLS:

- Pre-fabricated Sandwich Panel ‘AEROCON’ or equivalent of 50 mm thick Made up of two fiber Reinforced cement sheets on either Side of a lightweight concrete core composed of port land Cement, binders, Siliceous and micaceous material aggregate with tongue & groove arrangement.

4.3 ROOF:

- Roofing with 0.45MM thick Colour coated Sheets of Required size fixed to the purlins in gable Shape with self tapping Screws. The Roof shall either thermal insulated or provided with false ceiling.

4.4 CHANNELS:

- Galvanized iron top & bottom channels of size: 38 x 50 x 38 in 1 mm Thickness.

4.5 STEEL STRUCTURE:

- Fabricated structural steel for Columns with 72 X 72MM MS Square Box.
- Trusses with 50 NB MS Pipes for outer frame and 32 NB MS Pipes for internal bracings, & Purlins with 50 NB MS Pipes, Joint Plates 8MM thick, bolts, including one coat of Red- oxide primer.

4.6 COMPONENTS:

- Ridge covers on the roof ridge with plain CGI sheet, all four corners covered with MS Corner covers all fixed with the help of bolts, Nuts, Anchor fasteners, screws etc.

4.7 PAINTING

- (A) Interior: Painting of AEROCON or equivalent internal walls with one coat of cement Primer and two coats of Synthetic/Acrylic paints. (Oil bond distempers) of Asian / ICI make.
- (B) EXTERIOR: Painting of AEROCON or equivalent external walls with one coat of cement Primer and two Coats of exterior plastic emulsion of Asian / ICI make.

4.8 DOOR FRAME:

- Supply & fixing of 1.2 mm thick cold-rolled steel Sections of Size 40 x 50 x 40mm with three mild steel Hinges duly welded on one side as a complete Item of work.

4.9 DOOR SHUTTER:

- Supply & fixing of 30-mm hard core Flush door of boiling Waterproof Grade [BW Grade] including one Al drop, one doorstopper, two handles, one latch in chrome Plated steel.

4.10 WINDOW FRAME:

- Supply & fixing of 1.2 mm thick cold-rolled Steel sections
- In size: 40 x 50 x 28mm 10mm Burglar bars at every 100 mm Center.

4.11 WINDOW SHUTTERS:

- Supply & fixing of mild steel Z section of size: 25 x 25 mm fixed with two
- Hinges and two handles, two Stay rods as Pre required Size with 4mm thick glass In the MS Shutter.

4.12 ELECTRICAL:

- All light points will be connected with 1/18 wire with PVC casing.
- All power points will be connected with 3/20 gauge Wire & 1/18 earth, all the Cables will be Properly
- Conduited The wire will be any ISI mark, switches shall be Anchor or equivalent make. (Points only without fixtures)
- (Each Room Light Points = 2 No's, Fan Points = 2 No minimum, 5Amp Sockets = 4 No's)

4.13 TOILET, BATH AND KITCHEN AREA:

- The toilet, Bath and kitchen shall be of masonry structures and each toilet shall contain Indian Water Closet (IWC) with self-flushing mechanism, Along with suitable required taps. No of toilets shall be apprx. Minimum 1 No for every 5 persons.

4.14 WATER SUPPLY:

- Sintex/other water tanks shall be placed at suitable heights on top steel structure provided by the bidder for distribution of drinking water and service water. The water tank shall be connected to all taps for continuous supply of water. Measures shall be taken to install water saving devices and to prevent water wastage.

4.15 SEWAGE CONNECTION:

- Sanitary fitting along with sewage pipe shall be provided up to septic tank and soak pit. All internal and external plumbing (from water tank to distribution system like toilet and pantry) shall be provided by bidder.

- The waste water out of bathing shall be let out to nearest drain through masonry drain and stagnation of the waste water is strictly prohibited
- The septic tank and soak pit shall be designed by the bidder to accommodate the labour strength planned by them for mobilisation.

4.16 ELECRICAL WORKS:

Each Room in the prefabricated building shall contain the below mentioned fittings:

- Open Tube light 2 x 36 W
- 4Nos of 5 Amps Power socket
- Min 2 Nos of Ceiling Fan point with Fan
- The building should also contain DB's, Earth Pits, Outside light fittings and lights
- Suitable lighting shall be installed to illuminate the entire place using LED Sodium Vapour Lamps. Suitable motor room with water pump for pumping water from BHEL point to vendor Tank

4.17 KITCHEN & DINNING HALL:

- Kitchen shall be of masonry or pre-fabricated structures
- Space nearer to the labour shed shall be allocated for kitchen and dining hall which is exclusive for the particular bidder of the package awarded.
- Dining hall shall be common for all the labours of belongs to the bidder executing a particular package of work of BHEL.
- Dining hall shall be semi closed prefabricated structure shed with sides open and brick wall up to 1m from FFL of the shed
- Dining hall shall be provided with the seating arrangements made of wooden/plastic.
- Dining hall shall be provided with adequate lights, Fans
- All design work of prefabricated buildings, foundations, lighting, fittings, etc. shall be as per the latest Indian Standard Codes and in the scope of bidder.

- The waste water out of utensil cleaning shall be let out to nearest drain through masonry drain and stagnation of the waste water is strictly prohibited

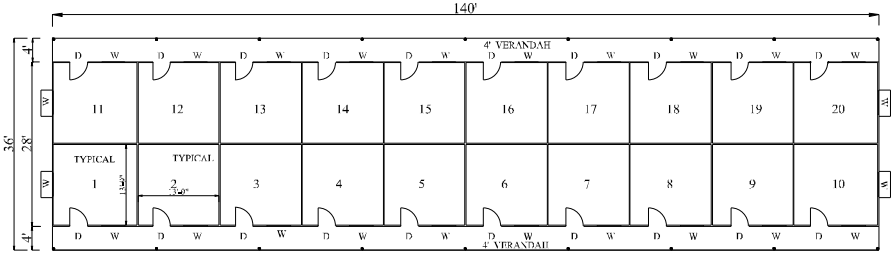
4.18 SALIENT TECHNICAL REQUIREMENTS:

- All design work of prefabricated buildings, foundations, lighting, fittings, etc. shall be as per the latest Indian Standard Codes.
- All designs have to be carried out as per relevant IS/International codes.
- Agency shall submit two sets of proposed drawings of labour colony with foundation, Electrical, Plumbing & other fittings etc., to BHEL-Site for approval within fifteen days from the receipt of LOI.
- Bidders should take care of all Indian site conditions, prevailing local laws etc. No claim shall be entertained to lack of knowledge of site condition.
- Hygienic activities of toilets, bath rooms and kitchen area shall be strictly followed by the bidder.
- Transport from Labour colony to work site shall be provided by the bidder daily.

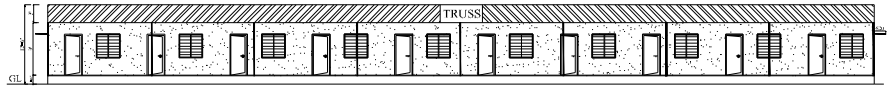
5.0 DRAWINGS & OTHER ENCLOSURES

Following drawings are enclosed strictly for the guidance of the Bidders:

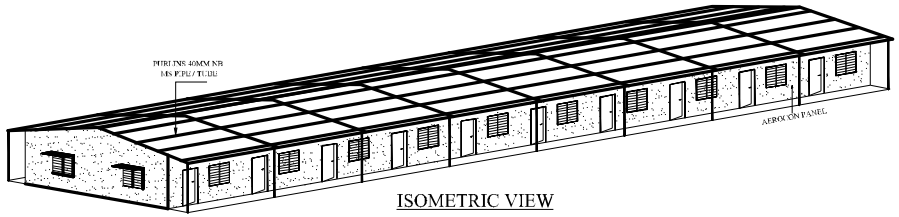
1. Standard Layout of Labour Colony (Typical) Drawing No-BHEL/PSSR/CVL/LABCOL/02, Rev-00
2. Standard drawing of pre-Fabricated Building(Typical) Drawing No-BHEL/PSSR/CVL/LABCOL/03, Rev-00



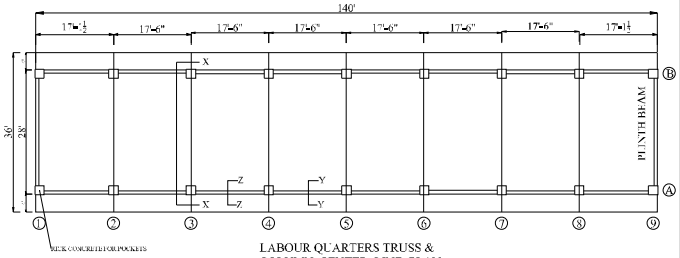
LABOUR QUARTERS PLAN



FRONT ELEVATION



ISOMETRIC VIEW



LABOUR QUARTERS TRUSS &
COLUMN CENTER LINE PLAN

N

E

INDEX:

2MM THK AEROCON PANELS UP TO 2745MM HT.

SPECIFICATION :

1. **Walls** : Pre- fabricated Sandwich Panel 'AEROCON ' (Manufactured by Hyderabad Industries Limited) of 50mm thick Made up of two fiber Reinforced cement sheets on either Side of a lightweight concrete core composed of port land Cement, binders Siliceous and micaceous material Aggregate with tongue & groove arrangement.

2. **Steel Structure**: Fabricated structural steel for Column, Trusses and purlins.

3. **Bottom Channels :** Galvanized iron jindal make Top and bottom channels of size 38x50x38 in 1mm Thickness.

4. **Components** : Ridge covers on the roof ridge with profiled sheet , all four corners covered with MS corner covers all fixed with the the helps of bolts,nuts, Anchor fasteners,screws etc.

5. **Chajja** : 50mm thick Aerocon Panels fixed to wall with 'L' braackets and bolts.

6. **Flooring** : Screed / Concrete Flooring .

7. **Roof**: Roofing with 0.47mm thick Colour coated sheets of United/ Global make Sheets of Required Size fixed to the purlins in gable Shape with self Tapping Screws.

8. **Door Frame** : Supply and fixing of 1.2mm thick cold-rolled steel Sections of Size 40x50x40mm with three mild steel Hinges duly welded on one side as complete item of work.

9. **Door Shutter** : Supply & fixing of 30mm hardcore Flush door of boiling waterproof Grade (BW Grade) including one Al-drop one door stopper ,two handles,one latch in chorme plated steel .

10. **Window Frame** : Supply & fixing of 1.2mm thick cold-rolled Sections in Size 40x50x28mm 10mm Burglar bars at every 100mm center.

11. **Window Shutter** : Supply & fixing of Mild steel Z-section of size : 25x25mm fixed with two Hinges and two handles, two stay rods as pre required Size with 4mm thick glass in the MS Shutter.

12. **Electrical** : All light points will be connected with 1.5 wire and a Proper earth , with PVC casing.

    All power points will be connected with 2.5 gauge wire and 1.5 Earth, all the Cables will be Properly.Conducted. The wire will be Finecab make, switchers shall be Anchore make. (Labour Qtrs : Light points = 50, Fan points = 20, ½ Amps = 20)

13. **Painting** (A) Interior : Painting of AEROCON internal walls with one coat of cement Primer and two coats of Synthetic / Acrylic paints.(Oil bond distempers) of Asian / ICI Make.

    (B) Exterior : Painting of AEROCON External walls with one coat of cement Primer and two coats of exterior plastic emulsion of Asian / ICI Make.

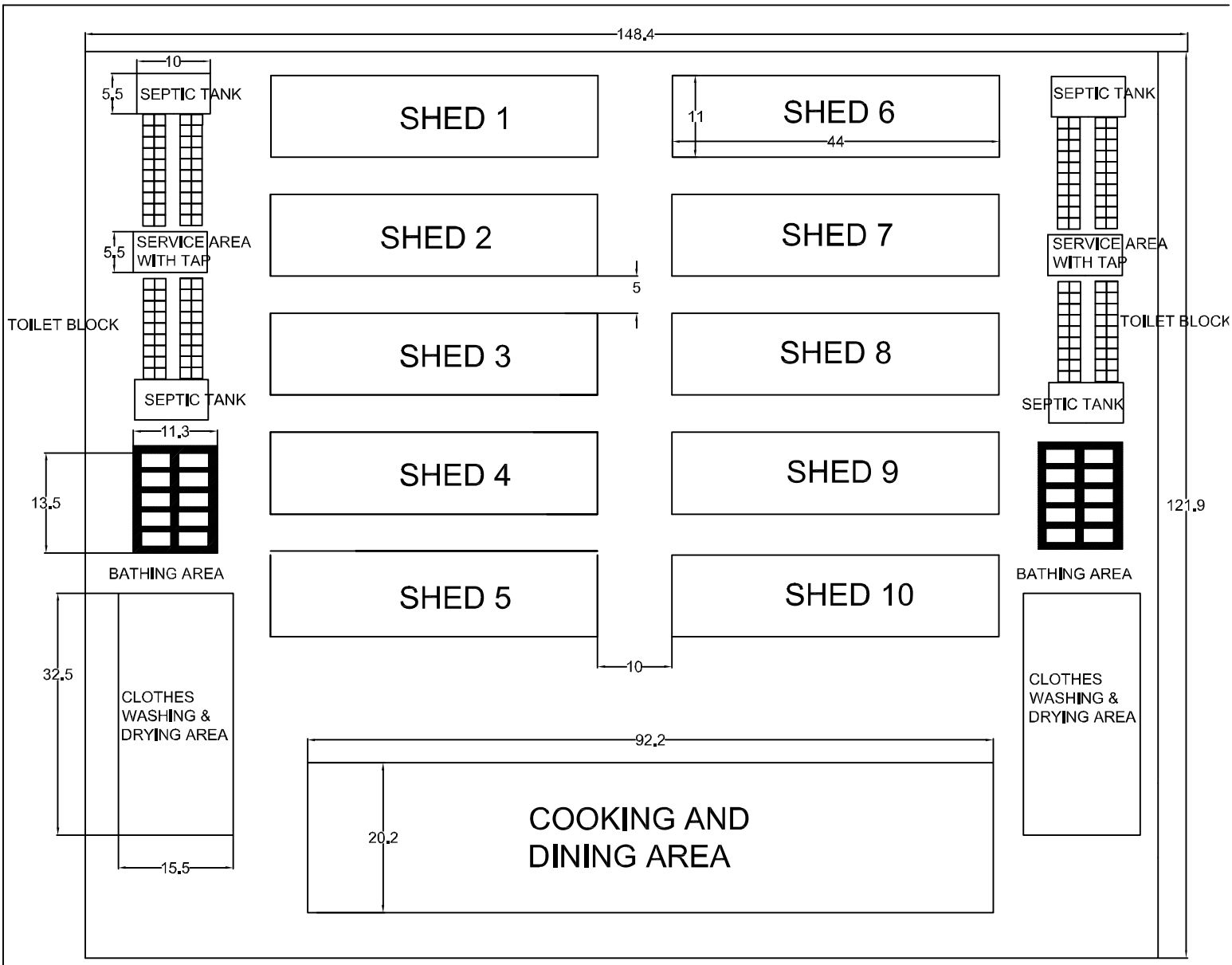
NOTE :
ALL DIMENSION ARE IN FEET .

COMPANY : BHEL PSSR

PROJECT:

TITLE: GENERAL LABOUR COLONY DETAILS

PREPARED BY	REVIEWEDPARED BY	CHECKED BY	APPROVED BY	SIZE	SCALE	DRG NO:	REV
					Not to Scale	BHEL:PSSR:CVL:LAB COL/02	0



ALL DIMENSIONS ARE IN METRES

TYPICAL LAYOUT OF LABOUR COLONY

CUSTOMER: BHEL

DRAWING NO: BHEL -PSSR-CVL-LABCOL-02 REV 00

BHARAT HEAVY ELECTRICALS LTD.
POWER SECTOR(FINANCE)- HEAD QUARTERS
ASIAD, NEW DELHI

From : Kalyan Coari
AGM-Finance

For : As Per Distribution List

No. PW:FM:FAX:T&P Hire :2019-21
Dated : 31st May, 2019

Subject : Revision of Hire Charges on Issue of Capital Tools & Plants

The rates of hire charges for capital Tools and Plants and Operator's charges circulated vide letter No. PWR:FM:T&P Hire 2017-19 dated 01st June,2017 were valid upto 31.5.2019. The Revised Rates effective from 01.06.2019 are enclosed as detailed below :

(i) Annexure C1 & T1 : Rates of hire charges applicable to contractors working for BHEL

(ii) Annexure C2 & T2 : Rates of hire charges applicable to outside agencies other than Contractors working for BHEL.

2. The Crane Operator's charges will be as follows :

A. **If BHEL operator is utilised Rs. 7200/- (Rupees Seven thousand two hundred only) per day of 8 hours.** For services less than 4 hours, half of per day rate will be charged. For services for 4 hours or more but up to 8 hours, full day rate will be charged. Overtime Allowance (OTA) will be charged at double the rate on hourly basis.

B. **If vendor sourced operator is provided, the rates shall be the actual cost to BHEL with 30% overheads.**

3. The hire charges of Capital Tools & Plants are exclusive of operating expenses e.g. fuel & consumables. **All Operating expenses are chargeable to User's account.**

4. All other terms and conditions / aspects governing the issue of T&P on Hire "will remain the same as already circulated vide our letter of even number dated 22.1.1992 (copy enclosed).

5. **The revised rates will be effective from 01.06.2019 and will remain valid upto 31.5.2021.** This will be subject to revision thereafter.

6. For any additional item, the rates of hire charges will be worked out jointly by PS-MSX & Finance (PS-Hqrs) on specific request. All necessary details will be provided by the concerned Region.

(Kalyan Coari) 31/05/19
AGM (Fin)

Encl : As above

आर॰एल॰ साहा
महा प्रबन्धक (वित्त)
R.L. SAHA
General Manager (Fin.)

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
Bharat Heavy Electricals Limited
पावर सेक्टर/Power Sector

REF: PWR:FAX:HIRE CHARGES
DT : 22.1.92.

SUBJECT ISSUE OF TOOLS AND PLANTS TO SUB-CONTRACTORS AND RECOVERY OF HIRE CHARGES THEREOF - - - -

The rates of hire charges for capital tools and plants last circulated vide Sr. Manager/Finance 's letter reference PWA:SMQ:FAX:24.02 dated 20.5.88 have been revised. The revised rates have been worked out based upon the recommendations of the study team set up vide office order No. PW:SMQ:FAX:11.36 Dt. 1.10.88. The study team's/committee's recommendations relating to issue of T&P to sub contractors A e enclose ; ra es of hire charges ave been worked out and are enclosed as follows :-

i) Annexures 1.1, 1.2, 1.3,&1.4
Rates for hire charges as applicable to contractors working for BHEL.

ii) Annexures 2.1 & 2.2
Rates of hire charges as applicable to outside agencies other than contractors working for BHEL.

iii) Annexure - III
Crane operators charges.

The important conditions/aspects governing the issue of T&P on hire are as follows :-

i) The tender documents shall specify :-

a) List of T&P to be provided by BHEL free of hire charges

b) List of T&P which may be given on hire, if available at site and the rate of hire charges recoverable for the same. For items and rates specified in the N.I.T. these charges shall not change during the currency of that contract. For items/rates not specified in N.I.T. the currentrates shall be charged.

ii) The rates given in Annexure 1.1, 1.2, & 2.1 are on hourly basis. The unit of recovery is an hour and for fraction of an hour, the chargeable unit will be an hour only. The rates given in Annexure 1.3, 1.4 & 2.2 are on day basis (day means a calender day) and fraction of a day will be charged as full day for purpose of recovery of hire charges.

...2/-

iii) Operator's charges are on per day basis considering average 8 working hours, For services of less than 4 hours, half the rates will be charged. For services of 4 hours upto 8 hours, full daily rates will be charged. Overtime will be charged at double the rates on hourly basis.

iv) The hire charges are recoverable on the basis of out time and in time i.e. from the time a particular item is issued to the contractor from BHEL's store till the time it is returned. However, where the hourly rate is applicable for T&P which cannot be frequently returned due to intermittent use, logging shall be done for actual use and charged accordingly. In case of cranes, marching time for onward and return shall be charged at 50% of the hire charges rates.

v) The rates do not include transportation charges from and to BHEL's store. Safe transportation of T&P from and to BHEL's store shall be the contractors responsibility.

vi) Small T&P items i.e. items costing less than Rs. 10,000/- each shall not be issued to contractors on hire charges. Such items may however be issued to contractors on non-returnable basis at replacement cost plus 30% overheads reduced by depreciation as applicable or a certain reserve price whichever is higher.

vii) If a contractor commits certain T&P at the time of award of contract/L.O.I. and fails to actually deploy the same in time at site, then even for contractors working for BHEL, higher rates of hire charges as given in Annex 2.1 & 2.2 shall be applicable for such items.

~~The revised rates of hire charges and operator's~~ charges as enclosed, together with terms stated above and other aspects/conditions relating to issue of T&P to sub contractors as given in Appendix I shall be effective from 1.2.1992 till 31.10.93 and will be subject to revision thereafter.

...3/-

For any additional item not appearing in the enclosed list, rates of hire charges may be calculated by TS HQ in consultation with PS-HQ (Finance) on receipt of necessary details from regions and communicated to the regions.

This issues with the approval of competent authority.

(R.L. SAHA)
GENERAL MANAGER (F)
PS-HQ

Encl : As above.

DISTRIBUTION :

ED, PS-NR, New Delhi
ED, PS-WR, NAGPUR
ED, PS-PEM, New Delhi
GM I/C PS-SR Madras
GM PS-ER CALCUTTA
ED/PMG&TS/New Delhi
Advisor (Finance) Corporate Office, N.Delhi.
S.A. to Director (Power).

Annexure

C1

DATE:31/05/2019

REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR
SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (BEYOND USEFUL LIFE)
I.	CRANES:-			
1	Portal Gantry Crane 500T	15	20100.00	19980.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	11370.00	11320.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	56290.00	55940.00
4	PORTAL CRANE, 360T	15	14070.00	13980.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	55460.00	55110.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	68610.00	68180.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	33510.00	33300.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	20940.00	20810.00
9	MANITOWOC M-250T TRUCK CRANE	15	30160.00	29970.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	31660.00	31470.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	26390.00	26220.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	36110.00	36110.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	15130.00	15030.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	18850.00	18850.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	16750.00	16650.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	21780.00	21640.00
15	CRAWLER CRANE SUMITOMO, 150T	15	10890.00	10820.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	13400.00	13320.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	10830.00	10780.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	10720.00	10650.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	8880.00	8820.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	10050.00	9990.00
20	CRAWLER CRANE 100 T (KH 500)	15	10050.00	9990.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	5410.00	5390.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6140.00	6110.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5370.00	5340.00
24	Mobile Crane, 55MT (TIL)	12	4410.00	4390.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3030.00	3010.00
26	MOBILE CRANE, 20MT (TIL)	10	2270.00	2260.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2270.00	2260.00
28	MOBILE CRANE ESCORTS- 14MT	10	710.00	710.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	390.00	380.00
30	ELECTRIC GANTRY CRANE 3T	5	430.00	430.00
31	ELECTRIC GANTRY CRANE 5T	5	540.00	540.00
32	ELECTRIC GANTRY CRANE 30T	5	3640.00	3620.00
33	FORK LIFT 5T	5	650.00	650.00
34	FORK LIFT 3T	5	540.00	540.00

Annexure C2 DATE:31/05/2019

REVISED RATES OF T&P HIRE CHARGES FOR CRANES & TRAILERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	USEFUL LIFE (IN YRS)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (WITHIN USEFUL LIFE)	Revised rates (Rs./Hour) valid from 01/06/2019 to 31/5/2021 (BEYOND USEFUL LIFE)
I.	CRANES:-			
1	Portal Gantry Crane 500T	15	22340.00	22200.00
2	100MT Crawler Crane ZOOMLION CRANE-QUY-100	10	12630.00	12570.00
3	Heavy Lift Crawler Crane 600MT Class DEMAG Model CC2800	15	62550.00	62160.00
4	PORTAL CRANE, 360T	15	15630.00	15540.00
5	600MT Class Crawler Crane- Manitowoc Model 18000-UPGRADED	15	61620.00	61240.00
6	600MT Class Crawler Crane- Liebherr Model LR1600-2 (Upgraded version)	15	76230.00	75760.00
7	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH RINGER)	15	37230.00	37000.00
8	CRAWLER CRANE FMC/LINKBELT 718, 250T (WITH-OUT RINGER)	15	23270.00	23120.00
9	MANITOWOC M-250T TRUCK CRANE	15	33510.00	33300.00
10	270 MT Class Crawler Crane- Manitowoc Model 2250	15	35180.00	34960.00
11	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1	15	29320.00	29130.00
11.A	300MT Crane Crawler Crane LIEBHERR Model LR-1350/1 (UPGRADED)	15	40120.00	40120.00
12	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2	15	16810.00	16700.00
12.A	250MT Class Mid range Crawler Crane- Kobelco Model CKE2500-2 (UPGRADED)	15	20950.00	20950.00
13	LINKBELT LS- 248H CRAWLER CRANE (180T)	15	18610.00	18500.00
14	MANITOWAC MODEL 888 CRAWLER CRANE (200 MT)	15	24200.00	24050.00
15	CRAWLER CRANE SUMITOMO, 150T	15	12100.00	12020.00
16	All Terrain Crane, 150MT- Liebherr Model LTM1150	15	14890.00	14800.00
17	CRAWLER CRANE, 120 T Fushun Model QUY120	10	12030.00	11970.00
18.A	CRAWLER CRANE 135MT Kobelco Model CK1350- 1F	15	11910.00	11840.00
18.B	CRAWLER CRANE 135MT Kobelco Model CK1350	15	9860.00	9800.00
19	CRAWLER CRANE 120MT - Tata-Sumitomo Model SCX1200-2	15	11170.00	11100.00
20	CRAWLER CRANE 100 T (KH 500)	15	11170.00	11100.00
21	Hydraulic Crawler Crane 80MT, Fushun Model QUY 80B	10	6010.00	5980.00
22	ROUGH TERRAIN CRANE 75T (RT880)	12	6830.00	6790.00
23	CRAWLER CRANE, 75T -Tata Model 955ALC/TFC280	12	5970.00	5940.00
24	Mobile Crane, 55MT (TIL)	12	4900.00	4880.00
25	CRAWLER CRANE, 25T -Tata Model TFC75	10	3370.00	3350.00
26	MOBILE CRANE, 20MT (TIL)	10	2520.00	2510.00
27	MOBILE CRANE, 20MT (ESCORTS)	10	2520.00	2510.00
28	MOBILE CRANE ESCORTS- 14MT	10	790.00	790.00
29	HYDAULIC PICK & CARRY CRANE, 8/9/10/11/12 MT	10	430.00	430.00
30	ELECTRIC GANTRY CRANE 3T	5	480.00	480.00
31	ELECTRIC GANTRY CRANE 5T	5	600.00	600.00
32	ELECTRIC GANTRY CRANE 30T	5	4040.00	4030.00
33	FORK LIFT 5T	5	720.00	720.00
34	FORK LIFT 3T	5	600.00	600.00

ANNEXURE-T I
DT: 31/05/2019

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	20930
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	310
3	MULTI SHEAVE PULLEY BLOCK 100T	630
4	MULTI SHEAVE PULLEY BLOCK 150T	1260
5	ELCTRIC WINCH 5T	1270
6	ELCTRIC WINCH 10T	2360
7	ELECTRIC WINCH 15 T	2150
8	PASSENGER CUM GOODS HOIST 1T	2270
9	FURNACE MAINTENANCE PLATFORM	5040
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2100
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	16380
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	8190
3	WELDING GENERATOR 320/300 A	300
4	WELDING RECTIFIER 400A/300A	300
5	WELDING RECTIFIER 600A	400
6	DIESEL WELDING GENERATOR 400A/300A	400
7	TRANSFORMER,600A	300
8	TRANSFORMER 300/400A	200
III	SERVICE PLANTS & ALLIED EQUIPT.	0
1	500KVA DIESEL GENERATOR	3800
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH CAPACITY WITHOUT STORAGE TANK	6370
3	-DO- , WITH STORAGE TANK	7280
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	910
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON	1360
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON	1820
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON	3640
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750	1270
9	Low Vacuum de-hydration unit	630
10	DIESEL GENERATING SET,250 KVA	1770
11	DIESEL GENERATING SET,25 KVA	500
12	VACUUM PUMP(ABSOLUTE V.C.)	540
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1090
14	ACID TRANSFER PUMP 20/50 T/HR	540
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	80
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4240

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
17	AIR COMPRESSORS 250/300/330/360/350 CFM	2730
18	AIR COMPRESSORS 140/150/190/210 CFM	910
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	1820
20	Industrial Blower 2000CFM	1270
21	Air Leak Test Blower (Flow: 40000 m^3/Hr)	1160
22	Air Blower (Flow: 20000 m^3/Hr)	940
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	630
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1630
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	1800
4	-do- Gun with nose Assembly only	540
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	36980
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	800
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1090
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1270
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1330
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2230
7	BOLT STRETCHING DEVICE	910
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	3640
9	ULTRASONIC FLAW DETECTOR	2730
10	MPI TEST KIT	360
11	GAS LEAK DETECTOR	270
12	VIBRATION/SOUND LEVEL METER IRD-306	360
13	VIBRATION/SOUND LEVEL METER IRD-308	360
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1450
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2540
16	SHOCK PULSE METER	630
17	HV.DC TEST KIT UPTO 50 KV	540
18	HV.DC TEST KIT ABOVE 50 KV	1000
19	HV.AC TEST KIT UPTO 50KV	810
20	HV.AC TEST KIT ABOVE 50KV	2910
21	MOTORISED MEGGER 2.5KV	400
22	MOTORISED MEGGAR 5KV	450
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	450
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1090
25	WAVEFORM ANALYSER	910
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1630
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1090
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	910
29	DIGITAL LOW RESISTANCE METER	630
30	DC POTENTIOMETER	180
31	PRECISION DEAD WEIGHT TESTER	1000
32	OPTICAL ALIGNMENT KIT	1360
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1200
34	VERNIER THEODOLITE,PRECISION	1200
35	VERNIER THEODOLITE,ORDINARY	200
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	120
37	ISKAMATIC 'A'	3200
38	CALIBRATOR '03'	1000
39	48 POLE EXTENDER CARD	200

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
40	MULTIJET NPM	400
41	OSCILLOMETER	10190
42	VOC EQUIPMENT	1400
43	BINARY SIGNAL GENERATOR	290
44	ELECTRIC COUNTER	690
45	FREQUENCY GENERATOR	1000
46	DBF 3 VIBRATION RECORDER/ANALYSER	3270
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	490
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1180
49	VIBROPORT 41/FFT ANALYSER	5460
50	ELCID kit	10010
51	UNIVERSAL CALIBRATION SYSTEM	2730
52	NATURAL FREQUENCY TESTER	2910
53	DIGITAL HARDNESS TESTER	360
54	ADRE 208 VIBRATION ANALYSER	7280
55	PCB DIAGONISTIC REPAIR KIT	2000
56	SECONDARY INJECTION RELAY TEST KIT	5270
57	MICRO OHM METER	1450
58	DIGITAL MICRO OHM METER MEASURING RANGE: 200 μΩ TO 20KΩ	3230
59	PMI Machine OLYMPUS make	3350
60	Mobile Lighting Mast - 9 metres (4X400 W)	860
61	10KVA RESISTANCE BRAZING MACHINE	140
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH PORTABLE HANDHELD OSCILLOSCOPE.	460
63	HYDROGEN GAS LEAK DETECTOR	50
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE ACCESSORIES	4980
65	WEDGE DEFLECTION KIT	80
66	TILE PRESSING MACHINE FOR GAS TURBINE	270
67	INDUCTION BRAZING MACHINE	4870
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	3640
69	ULTRASONIC FLOW METER	180
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	40
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -14KG/SQ CM. ; FLOW 60 M3/HR	470
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR AND PANEL) : PRESSURE -30KG/SQ CM. ; FLOW 15 M3/HR	430
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL DL850E-Q-HE/B5/HD1	1810
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1260
75	5KV Insulation Tester	450
76	4 Channel Digital Oscilloscope /Fast Recorder	1710
77	4 Channel Oscillographic Recorder	580
78	Sound Level Meter	230
79	Thermal Imaging Camera	770
80	Videoscope (Video Boroscope)	1510
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1310
82	Conductivity Meter	80
83	Core Flux Test Kit	7280
84	Primary Current Injection Kit (2000A)	870
85	3 Phase Secondary Injection Kit (Relay Test)	3760
86	FRF Filtration Kit	1330
87	FFT Analyser	2290

ANNEXURE-T I
DT: 31/05/2019

RATES OF T&P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILERS ETC. FOR SUB-CONTRACTORS WORKING FOR BHEL FOR DOING BHEL JOBS

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
88	Flue Gas Analyser	1030
89	Oil Test Kit (Mineral Oil)-Transformer	1010
90	Winding Resistance kit (R L C Load)	880
91	SFRA test Kit	1190
92	Tan Delta test Kit	4060
93	PF Meter	330
94	Ultrasonic Flow Meter	830
95	Oil Particle Counter	360

ANNEXURE-T II
DT: 31/05/2019

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
I.	LIFTING EQUIPMENTS	
1	Strand Jack System for Boiler Drum Lifting	23250
2	MULTI SHEAVE PULLEY BLOCK 40/50T/60T	350
3	MULTI SHEAVE PULLEY BLOCK 100T	700
4	MULTI SHEAVE PULLEY BLOCK 150T	1400
5	ELCTRIC WINCH 5T	1410
6	ELCTRIC WINCH 10T	2620
7	ELECTRIC WINCH 15 T	2390
8	PASSENGER CUM GOODS HOIST 1T	2520
9	FURNACE MAINTENANCE PLATFORM	5600
10	Gang Operated Hydraulic Jack (Set of 4 Jacks - 175 MT each)	2330
II	WELDING & HEAT TREATMENT EQUIPMENT	
1	125KW, 3KHZ, AIR-COOLED INDUCTION HEATING EQUIPMENT	18190
2	75KW, 10 KHZ, COMPACT INDUCTION HEATING EQUIPMENT	9090
3	WELDING GENERATOR 320/300 A	330
4	WELDING RECTIFIER 400A/300A	330
5	WELDING RECTIFIER 600A	440
6	DIESEL WELDING GENERATOR 400A/300A	440
7	TRANSFORMER,600A	330
8	TRANSFORMER 300/400A	220
III	SERVICE PLANTS & ALLIED EQUIPT.	
1	500KVA DIESEL GENERATOR	4220
2	TRANSFORMER OIL FILTERATION EQUIPMENT 6000LPH	7070
3	-DO- , WITH STORAGE TANK	8080
4	OIL FILTERATION M/C, 250/500 LPH (OTHER THAN SILICON OIL)	1010
5	OIL FILTERATION M/C, 250GPH/1000LPH (OTHER THAN SILICON	1510
6	OIL FILTERATION M/C, 500GPH/2500LPH (OTHER THAN SILICON	2020
7	OIL FILTERATION M/C, 1000GPH/5000LPH (OTHER THAN SILICON	4040
8	Portable Lube Oil Purification Unit (Centrifuge M/c) Capacity: 750	1410
9	Low Vacuum de-hydration unit	700
10	DIESEL GENERATING SET,250 KVA	1970
11	DIESEL GENERATING SET,25 KVA	560
12	VACUUM PUMP(ABSOLUTE V.C.)	600
13	ACID CIRCULATING PUMP WITH MOTOR 120M HEAD, 150T/HR	1210
14	ACID TRANSFER PUMP 20/50 T/HR	600
15	DEWATERING PUMP (Kirloskar make,11KW/15HP)	90
16	HP Air compressor (32 Kg/Sq. Cm, 150 CFM)	4710

ANNEXURE-T II
DT: 31/05/2019

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
17	AIR COMPRESSORS 250/300/330/360/350 CFM	3030
18	AIR COMPRESSORS 140/150/190/210 CFM	1010
19	ACID CIRCULATING PUMP WITH MOTOR & STARTER, 200T/HR, 150M, 220 HP	2020
20	Industrial Blower 2000CFM	1410
21	Air Leak Test Blower (Flow: 40000 m^3/Hr)	1290
22	Air Blower (Flow: 20000 m^3/Hr)	1040
IV	METAL FORMING /CUTTING EQUIPMENT	
1	TUBE EXPANDING M/C PNEUMATIC 60-100 MM	700
2	ELECTRO HYDRAULIC PIPE BENDING M/C 4"	1810
3	BOLTING MACHINE (ALCOA/AVLOCK/ HUCK)	2000
4	-do- Gun with nose Assembly only	600
V	TESTING/INSPECTION EQUIPMENT	
1	DATA LOGGER for PG TESTING	41090
2	MOTORISED HYDRAULIC TEST PUMP 250kg/cmsq	880
3	MOTORISED HYDRAULIC TEST PUMP 400-450kg/cmsq	1210
4	MOTORISED HYDRAULIC TEST PUMP 600 KG/CMSQ	1410
5	HYDRAULIC TEST PUMP 800 KG/CMSQ	1480
6	HYDRAULIC TEST PUMP 1000 KG/CMSQ	2480
7	BOLT STRETCHING DEVICE	1010
8	BOROSCOPE/FIBROSCOPE FLEXIBLE TYPE (FLEXUX) IMPORTED	4040
9	ULTRASONIC FLAW DETECTOR	3030
10	MPI TEST KIT	400
11	GAS LEAK DETECTOR	300
12	VIBRATION/SOUND LEVEL METER IRD-306	400
13	VIBRATION/SOUND LEVEL METER IRD-308	400
14	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 350	1610
15	VIBRATION ANALYSER/DYNAMIC BALANCING M/C IRD 360	2830
16	SHOCK PULSE METER	700
17	HV.DC TEST KIT UPTO 50 KV	600
18	HV.DC TEST KIT ABOVE 50 KV	1110
19	HV.AC TEST KIT UPTO 50KV	900
20	HV.AC TEST KIT ABOVE 50KV	3230
21	MOTORISED MEGGER 2.5KV	440
22	MOTORISED MEGGAR 5KV	500
23	OSCILLOSCOPE-DUAL BEAM INDIGENOUS	500
24	OSCILLOSCOPE-DUAL BEAM IMPORTED	1210

ANNEXURE-T II
DT: 31/05/2019

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
25	WAVEFORM ANALYSER	1010
26	OSCILLOGRAPH/UV RECORDER 24 CHANNEL	1810
27	OSCILLOGRAPH/UV RECORDER 12 CHANNEL	1210
28	OSCILLOGRAPH/UV RECORDER 6 CHANNEL	1010
29	DIGITAL LOW RESISTANCE METER	700
30	DC POTENTIOMETER	200
31	PRECISION DEAD WEIGHT TESTER	1110
32	OPTICAL ALIGNMENT KIT	1510
33	BOROSCOPE/FIBROSCOPE(NON FLEXIBLE)	1330
34	VERNIER THEODOLITE,PRECISION	1330
35	VERNIER THEODOLITE,ORDINARY	220
36	ENGINEERS PRECISION LEVEL/DUMPY LEVEL	130
37	ISKAMATIC 'A'	3550
38	CALIBRATOR '03'	1110
39	48 POLE EXTENDER CARD	220
40	MULTIJET NPM	440
41	OSCILLOMETER	11320
42	VOC EQUIPMENT	1550
43	BINARY SIGNAL GENERATOR	320
44	ELECTRIC COUNTER	760
45	FREQUENCY GENERATOR	1110
46	DBF 3 VIBRATION RECORDER/ANALYSER	3630
47	L&T GOULD OSCILLOGRAPH 2-CHANNEL	540
48	L&T GOULD OSCILLOGRAPH 6-CHANNEL	1310
49	VIBROPORT 41/FFT ANALYSER	6060
50	ELCID kit	11120
51	UNIVERSAL CALIBRATION SYSTEM	3030
52	NATURAL FREQUENCY TESTER	3230
53	DIGITAL HARDNESS TESTER	400
54	ADRE 208 VIBRATION ANALYSER	8080
55	PCB DIAGONISTIC REPAIR KIT	2220
56	SECONDARY INJECTION RELAY TEST KIT	5860
57	MICRO OHM METER	1610
58	DIGITAL MICRO OHM METER	3590
59	PMI Machine OLYMPUS make	3730
60	Mobile Lighting Mast -	960
61	10KVA RESISTANCE BRAZING MACHINE	160
62	RECURRENT SURGE OSCILLOGRAPH (RSO) TEST KIT WITH	510

ANNEXURE-T II

DT: 31/05/2019

RATES OF T & P HIRE CHARGES FOR ITEMS OTHER THAN CRANES & TRAILLERS ETC. FOR OUTSIDE AGENCIES

SL NO.	ITEM DESCRIPTION	Revised rates (Rs./Day) valid from 01/06/2019 to 31/5/2021
63	HYDROGEN GAS LEAK DETECTOR	60
64	STATOR WEDGE ANALYZER KIT WITH COMPLETE	5530
65	WEDGE DEFLECTION KIT	90
66	TILE PRESSING MACHINE FOR GAS TURBINE	300
67	INDUCTION BRAZING MACHINE	5410
68	MAGNETIC COHESIVE FORCE (MCF) EQUIPMENT	4040
69	ULTRASONIC FLOW METER	200
70	PORTABLE VIBRATION ANALYSER (MODEL 811T)	50
71	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR	520
72	CENTRIFUGAL PUMP SET FOR ACID CLEANING (WITH MOTOR	480
73	HI SPEED MEMORY RECORDER, MAKE -YOKOGAWA, MODEL	2010
74	TROLLEY MOUNTED HYDRAULIC JACK (100 MT)	1400
75	5KV Insulation Tester	500
76	4 Channel Digital Oscilloscope /Fast Recorder	1900
77	4 Channel Oscillographic Recorder	650
78	Sound Level Meter	260
79	Thermal Imaging Camera	860
80	Videoscope (Video Boroscope)	1680
81	DO (Dissolve Oxygen) Meter (0 to 1500 ppb)	1460
82	Conductivity Meter	90
83	Core Flux Test Kit	8090
84	Primary Current Injection Kit (2000A)	960
85	3 Phase Secondary Injection Kit (Relay Test)	4180
86	FRF Filtration Kit	1480
87	FFT Analyser	2550
88	Flue Gas Analyser	1140
89	Oil Test Kit (Mineral Oil)-Transformer	1120
90	Winding Resistance kit (R L C Load)	970
91	SFRA test Kit	1320
92	Tan Delta test Kit	4510
93	PF Meter	360
94	Ultrasonic Flow Meter	920
95	Oil Particle Counter	400

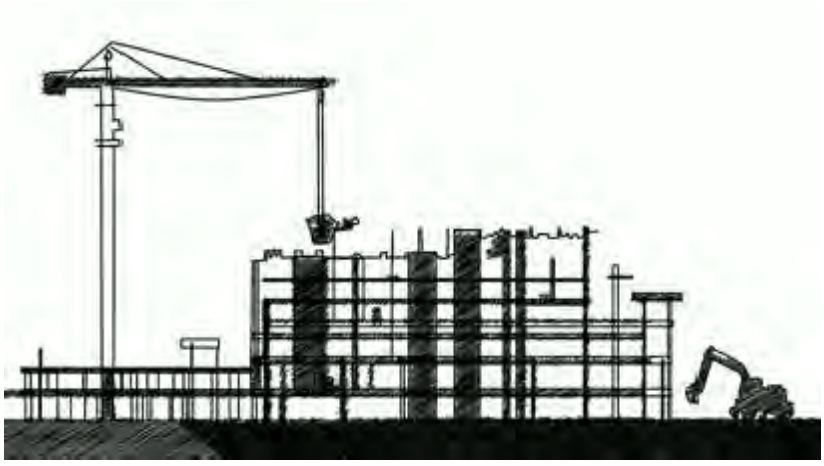
HEALTH, SAFETY and ENVIRONMENT PLAN

for

SITE OPERATIONS

by

SUB-CONTRACTORS



POWER SECTOR

HSE PLAN FOR SITE OPRATIONS BY BHEL'S SUBCONTRACTORS

AT A GLANCE

BEFORE START

SIGNING OF MOU
Agree to comply to HSE requirement- Statutory and BHEL's

PLAN

HSE ORGANISATION	
Manpower • 1 (one) safety officer for every 500 workers or part thereof • 1(one) safety-steward/ supervisor for every 100 workers **Qualification** As per Cl. 7.1	**HSE Roles and responsibilities** • Site In-charge- As per clause 7.2.1 • Safety officer- As per clause 7.2.2

HSE Planning
for Man, Machinery/Equipment/Tools & Tackles

PROVIDE

HSE INFRASTUCTURE	
• PPEs • Drinking Water • Washing Facilities • Latrines and Urinals • Provision of shelter for rest • Medical facilities	• Canteen facilities • Labour Colony • Emergency Vehicle • Pest Control • Scrapyard • Illumination

TRAIN

HSE TRAINING , AWARENESS & PROMOTION	
Training • Induction training • Height work and other critical areas • Tool Box talk & Pep Talk	**Awareness & Promotion** • Signage • Poster • Banner • Competition • Awards

COMMUNICATE

HSE COMMUNICATION	
Incident Reporting • Accident- Fatal & Major • Property damage • Near Miss	**Event Reporting** • Celebrations • Training • Medical camp

EXECUTE SAFELY

OPERATIONAL CONTROL PROCEDURES

PERMIT TO WORK

Height work (above 2 metres), Hot Work, Heavy Lifting, Confined Space, Radiography, excavation (More than 4 metres)

SAFETY DURING WORK EXECUTION	
• Welding • Rigging • Cylinder- storage & Movement • Demolition work • T&Ps • Chemical Handling • Electrical works	• Fire • Scaffolding • Height work • Working Platform • Excavation • Ladder • Lifting • Hoisting appliance
HOUSE KEEPING	
WASTE MANGEMENT	
TRAFFIC MANAGEMENT	
ENVIRONMENTAL CONTROL	
EMERGENCY PREPAREDNESS AND RESPONSE PLAN	

CHECKS

HSE AUDITS & INSPECTION	
• Daily Checks • Inspection of PPEs • Inspection of T& Ps • Inspection of Cranes & Winches	• Inspection of Height work • Inspection of Welding and Gas cutting • Inspection of elevators etc.

HSE PERFORMANCE EVALUATION PARAMETERS

NON CONFORMANCE

PENALTY for NON CONFORMANCE

Refer Clause 16

Incremental penalty

For repeated violation by the same person, the penalty would be double of the previous penalty

For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

REVISION HISTORY SHEET

Date	Revision No.	Details of Changes	Reason	Prepared	Reviewed	Approved
12.08.2014	00	First Issue	First Issue	S. B. Jayant, Dy Manager-FQA & Safety	A. K. Sinha, GM-FQA & Safety	Anuj Bhatnagar, ED-FQA & Safety
20.01.2020	01	Formats added: **HSEP:14-F30 – Monthly HSE Planning & Review** (Page 11, Clause 8.0 - updated) HSEP:14-F13E-Excavation Inspection Format (part of F30)) HSEP:14-F32B – Job Safety Analysis Format (part of F30) **HSEP:14-F31A – Daily HSE Reporting** (Page 18, Clause 10.3 – added) **HSEP:14-F33 – HSE Performance Evaluation** (Page 31, Clause 13 – revised)	IOM No. **PSHQHSE/MONREP/02** Dated 08-Jan-2020	Rohit Kumar	Santosh Nair, GM (MSX & HSE)	

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1.0 PURPOSE

1.1 The purpose of this HSE Plan is to provide for the systematic identification, evaluation, prevention and control of general workplace hazards, specific job hazards, potential hazards and environmental impacts that may arise from foreseeable conditions during installation and servicing of industrial projects and power plants.

1.2 This document shall be followed by BHEL's subcontractors at all installation and servicing sites. In case customer specific documents are to be implemented, this document will be followed in conjunction with customer specific documents.

1.3 Although every effort has been made to make the procedures and guidelines in line with statutory requirements, in case of any discrepancy relevant statutory guidelines must be followed.

1.4 In case the customer has any specific requirement, the same is to be fulfilled.

2.0 SCOPE

The document is applicable for BHEL's Subcontractors at all installation / servicing activities of BHEL Power Sector as per the relevant contractual obligations.

3.0 OBJECTIVES AND TARGETS

The HSE Plan reflects that BHEL places high priority upon the Occupational Health, Safety and Environment at workplaces.

- Ensure the Health and Safety of all persons at work site is not adversely affected by the work.
- Ensure protection of environment of the work site.
- Comply at all times with the relevant statutory and contractual HSE requirements.
- Provide trained, experienced and competent personnel. Ensure medically fit personnel only are engaged at work.
- Provide and maintain plant, places and systems of work that are safe and without risk to health and the environment.
- Provide all personnel with adequate information, instruction, training and supervision on the safety aspect of their work.
- Effectively control, co-ordinate and monitor the activities of all personnel on the Project sites including subcontractors in respects of HSE.
- Establish effective communication on HSE matters with all relevant parties involved in the Project works.
- Ensure that all work planning takes into account all persons that may be affected by the work.
- Ensure fitness testing of all T&Ps/Lifting appliances like cranes, chain pulley blocks etc. are to be certified by competent person.
- Ensure timely provision of resources to facilitate effective implementation of HSE requirements.
- Ensure continual improvements in HSE performance
- Ensure conservation of resources and reduction of wastage.
- Capture the data of all incidents including near misses, process deviation etc. Investigate and analyze the same to find out the root cause.
- Ensure timely implementation of correction, corrective action and preventive action.

HSE TARGETS

EXPLOSION	**ZERO**
FATALITY	**ZERO**
LOST TIME INJURY	**ZERO**
FIRE	**ZERO**
VEHICLE INCIDENTS	**ZERO**
ENVIRONMENTAL INCIDENTS	**ZERO**

4.0 BHEL POWER SECTOR HEALTH, SAFETY & ENVIRONMENT POLICY

Health, Safety & Environment Policy of BHEL

In BHEL, Health, Safety and Environment (HSE) responsibilities are driven by our commitment to protect our employees and people we work with, community and environment. BHEL believes in zero tolerance for unsafe work/non-conformance to safety and in minimizing environmental footprint associated with all its business activities. We commit to continually improve our HSE performance by:

- Developing safety and sustainability culture through active leadership and by ensuring availability of required resources.
- Ensuring compliance with applicable legislation, regulations and BHEL systems.
- Taking up activities for conservation of resources and adopting sound waste management by following Reduce/Recycle/Reuse approach.
- Continually identifying, assessing and managing environmental impacts and Occupational Health & Safety risks of all activities, products and services adopting approach based on elimination/ substitution/reduction/control.
- Incorporating appropriate Occupational Health, Safety and Environment criteria into business decisions, design of products & systems and for selection of plants, technologies and services.
- Imparting appropriate structured training to all persons at workplace and promoting awareness amongst customers, contractors and suppliers on HSE issues.
- Reviewing periodically this policy and HSE Management Systems to ensure its relevance, appropriateness and effectiveness.
- Communicating this policy within BHEL and making it available to interested parties.

sd/-

CMD, BHEL

5.0 MEMORANDUM OF UNDERSTANDING:

After award of work, subcontractors are required to enter into a memorandum of understanding as given below:

Memorandum of Understanding

BHEL, Power Sector_____Region is committed to Health, Safety and Environment Policy (HSE Policy).

M/s_____do hereby also commit to comply with the same HSE Policy while executing the Contract Number _____

M/s_____shall ensure that safe work practices as per the HSE plan. Spirit and content therein shall be reached to all workers and supervisors for compliance.

In addition to this, M/S_____shall comply to all applicable statutory and regulatory requirements which are in force in the place of project and any special requirement specified in the contract document of the principal customer.

M/s_____shall co-operate in HSE audits/inspections conducted by BHEL /customer/ third party and ensure to close any non-conformity observed/reported within prescribed time limit.

Signed by authorized representative of M/s ----------

Name :

Place & Date:

6.0 TERMS AND DEFINITIONS

6.1 DEFINITIONS

6.1.1 INCIDENT

Work- related or natural event(s) in which an injury, or ill health (regardless of severity), damage to property or fatality occurred, or could have occurred.

6.1.2 NEAR MISS

An incident where no ill health, injury, damage or other loss occurs, but it had a potential to cause, is referred to as "Near-Miss".

6.1.3 MAN-HOURS WORKED

The total number of man hours worked by all employees including subcontractors working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers including contract labours. Man-hours worked shall be calculated from the payroll or time clock recorded including overtime. When this is not feasible, the same shall be estimated by multiplying the total man-days worked for the period covered by the number of hours worked per day. The total number of workdays for a period is the sum of the number of men at work on each day of period. If the daily hours vary from department to department separate estimate shall be made for each department and the result added together.

6.1.4 FIRST AID CASES

First aids are not essentially all reportable cases, where the injured person is given medical treatment and discharged immediately for reporting on duty, without counting any lost time.

6.1.5 LOST TIME INJURY

Any work injury which renders the injured person unable to perform his regular job or an alternative restricted work assignment on the next scheduled work day after the day on which the injury occurred.

6.1.6 MEDICAL CASES

Medical cases come under non-reportable cases, where owing to illness or other reason the employee was absent from work and seeks Medical treatment.

6.1.7 TYPE OF INCIDENTS & THEIR REPORTING:

The three categories of Incident are as follows:

Non-Reportable Cases:
An incident, where the injured person is given medical help and discharged for work without counting any lost time.

Reportable Cases:
In this case the injured person is disable for 48 hours or more and is not able to perform his duty.

Injury Cases:
These are covered under the heading of non-reportable cases. In these cases the incident caused injury to the person, but he still continues his duty.

6.1.8 TOTAL REPORTABLE FREQUENCY RATE

Frequency rate is the number of Reportable Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula read as:

$$\frac{\text{Number of Reportable LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

6.1.9 SEVERITY RATE

Severity rate is the Number of days lost due to Lost Time Injury (LTI) per one Million Man hours worked. Mathematically, the formula reads as:

$$\frac{\text{Days lost due to LTI}}{\text{Total Man Hours Worked}} \times 1{,}000{,}000$$

6.1.10 INCIDENCE RATE

Incidence Rate is the Number of LTI per one thousand manpower deployed. Mathematically, the formula reads as:

$$\frac{\text{Number of LTI}}{\text{Average number of manpower deployed}} \times 1000$$

7.0 HSE ORGANISATION

Number of safety officers:
The subcontractor must deploy one safety officer for every 500 workers or part thereof in each package. In addition, there must be one safety-steward/safety-supervisor for every 100 workers.

Deployment: The subcontractor should deploy sufficient safety officers and safety-steward/Safety-supervisor, as per requirement given above, since initial stage and add more in proportion to the added strength in work force. Any delay in deployment will attract a penalty of Rs.30,000/- per man month for the delayed period.

7.1 QUALIFICATION FOR HSE PERSONNEL

Sl.no	Designation	Qualification	Experience
1	Safety officer (Construction Agency)	Degree or Diploma in Engineering with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years for degree holder and five years for diploma holder in the field of Construction of power plant/ major industries

2	Safety-Steward/ Safety-Supervisor	Degree or diploma in any discipline with full time diploma in Industrial Safety with construction safety as one of the subjects	Minimum two years

7.2 RESPONSIBILITIES

7.2.1 SITE IN -CHARGE OF SUBCONTRACTOR

- Shall sign Memorandum of Understanding (MoU) for compliance to BHEL's HSE Plan for Site Operations as per clause 5.0
- Shall engage qualified safety officer(s) and steward (s) as per clause 7.0
- Shall adhere to the rules and regulations mentioned in this code, practice very strictly in his area of work in consultation with his concerned engineer and the safety coordinator.
- Shall screen all workmen for health and competence requirement before engaging for the job and periodically thereafter as required.
- Shall not engage any employee below 18 years.
- Shall arrange for all necessary PPEs like safety helmets, belts, full body harness, shoes, face shield, hand gloves etc. before starting the job. Shall ensure that no working men/women carry excessive weight more than stipulated in Factory Rule Regulation R57.
- Shall ensure that all T&Ps engaged are tested for fitness and have valid certificates from competent person.
- Shall ensure that provisions stipulated in contract Labour Regulation Act 1970, Chapter V C.9, canteen, rest rooms/washing facilities to contracted employees at site.
- Shall adhere to the instructions laid down in Operation Control Procedures (OCPs) available with the site management.
- Shall ensure that person working above 2.0 meter should use Safety Harness tied to a life line/stable structure.
- Shall ensure that materials are not thrown from height. Cautions to be exercised to prevent fall of material from height.
- Shall report all incidents (Fatal/Major/Minor/Near Miss) to the Site engineer /HSE officer of BHEL.
- Shall ensure that Horseplay is strictly forbidden.
- Shall ensure that adequate illumination is arranged during night work.
- Shall ensure that all personnel working under subcontractor are working safely and do not create any Hazard to self and to others.
- Shall ensure display of adequate signage/posters on HSE.
- Shall ensure that mobile phone is not used by workers while working.
- Shall ensure conductance of HSE audit, mockdrill, medical camps, induction training and training on HSE at site.
- Shall ensure full co-operation during HQ/External /Customer HSE audits.

- Shall ensure submission of look-ahead plan for procurement of HSE equipment's and PPEs as per work schedule.
- Shall ensure good housekeeping.
- Shall ensure adequate valid fire extinguishers are provided at the work site.
- Shall ensure availability of sufficient number of toilets /restrooms and adequate drinking water at work site and labour colony.
- Shall ensure adequate emergency preparedness.
- Shall be member of site HSE committee and attend all meetings of the committee
- Power source for hand lamps shall be maximum of 24 v.
- Temporary fencing should be done for open edges if Hand – railings and Toe-guards are not available.

7.2.2 HEALTH, SAFETY AND ENVIRONMENT OFFICER OF SUBCONTRACTOR

- Carry out safety inspection of Work Area, Work Method, Men, Machine & Material, P&M and other tools and tackles.
- Facilitate inclusion of safety elements into Work Method Statement.
- Highlight the requirements of safety through Tool-box / other meetings.
- Help concerned HOS to prepare Job Specific instructions for critical jobs.
- Conduct investigation of all incident/dangerous occurrences & recommend appropriate safety measures.
- Advice & co-ordinate for implementation of HSE permit systems, OCPs & MPs.
- Convene HSE meeting & minute the proceeding for circulation & follow-up action.
- Plan procurement of PPE & Safety devices and inspect their healthiness.
- Report to PS Region/HQ on all matters pertaining to status of safety and promotional program at site level.
- Facilitate administration of First Aid
- Facilitate screening of workmen and safety induction.
- Conduct fire Drill and facilitate emergency preparedness
- Design campaigns, competitions & other special emphasis programs to promote safety in the workplace.
- Apprise PS– Region on safety related problems.
- Notify site personnel non-conformance to safety norms observed during site visits / site inspections.
- Recommend to Site In charge, immediate discontinuance of work until rectification, of such situations warranting immediate action in view of imminent danger to life or property or environment.
- To decline acceptance of such PPE / safety equipment that do not conform to specified requirements.
- Encourage raising Near Miss Report on safety along with, improvement initiatives on safety.
- Shall work as interface between various agencies such customer, package-in-charges, subcontractors on HSE matters

8.0 PLANNING BY SUBCONTRACTOR

Monthly planning and review of HSE activities shall be carried out by subcontractor as per format No. HSEP:14-F30 jointly along with BHEL.

8.1 MOBILISATION OF MACHINERY/EQUIPMENT/TOOLS BY SUBCONTRACTOR

- As a measure to ensure that machinery, equipment and tools being mobilized to the construction site are fit for purpose and are maintained in safe operating condition and complies with legislative and owner requirement, inspection shall be arranged by in-house competent authority for acceptance as applicable.

- The machinery and equipment to be embraced for this purpose shall include but not limited to the following:

  - Mobile cranes.
  - Side Booms.
  - Forklifts.
  - Grinding machine.
  - Drilling machine.
  - Air compressors.
  - Welding machine.
  - Generator sets.
  - Dump Trucks.
  - Excavators.
  - Dozers
  - Grit Blasting Equipment.
  - Hand tools.

- Subcontractor shall notify the engineer, of his intention to bring on to site any equipment or any container, with liquid or gaseous fuel or other substance which may create a hazard. The Engineer shall have the right to prescribe the condition under which such equipment or container may be handled and used during the performance of the works and the subcontractor shall strictly adhere to such instructions. The Engineer shall have the right to inspect any construction tool and to forbid its use, if in his opinion it is unsafe. No claim due to such prohibition will be entertained.

8.2 MOBILISATION OF MANPOWER BY SUBCONTRACTOR

- The subcontractor shall arrange induction and regular health check of their employees as per schedule VII of BOCW rules by a registered medical practitioner.
- The subcontractor shall take special care of the employees affected with occupational diseases under rule 230 and schedule II of BOCW Rules. The employees not meeting the fitness requirement should not be engaged for such job.
- Ensure that the regulatory requirements of excessive weight limit (to carry/lift/ move weights beyond prescribed limits) for male and female workers are complied with.
- Appropriate accommodation to be arranged for all workmen in hygienic condition.

8.3 PROVISION OF PPEs

- Personnel Protective Equipment (PPEs), in adequate numbers, will be made available at site & their regular use by all concerned will be ensured
- The following matrix recommends usage of minimum PPEs against the respective job.

Sl. No	Type of work	PPEs
1	Concrete and asphalt mixing	Nose mask, hand glove, apron and gum boot
2	Welders/Grinders/ Gas cutters	Welding/face screen, apron, hand gloves, nose mask and ear muffs if noise level exceeds 90dB. Helmet fitted with welding shield is preferred for welders
3	Stone/ concrete breakers	Ear muffs, safety goggles, hand gloves
4	Electrical Work	Rubber hand glove, Electrical Resistance shoes
5	Insulation Work	Respiratory mask, Hand gloves, safety goggles
6	Work at height	Double lanyard full body harness, Fall arrestor (specific cases)
7	Grit/Sand blasting	Blast suit, blast helmet, respirator, leather gloves
8	Painting	Plastic gloves, Respirators (particularly for spray painting)
9	Radiography	As per BARC guidelines

- The PPEs shall conform to the relevant standards as below and bear ISI mark.

Relevant is-codes for personal protection

IS: 2925 – 1984	Industrial Safety Helmets.
IS: 4770 – 1968	Rubber gloves for electrical purposes.
IS: 6994 – 1973 (Part-I)	Industrial Safety Gloves (Leather &Cotton Gloves).
IS: 1989 – 1986 (Part-I-II)	Leather safety boots and shoes.
IS: 5557 – 1969	Industrial and Safety rubber knee boots.
IS: 6519 – 1971	Code of practice for selections care and repair of Safety footwear.
IS: 11226 – 1985	Leather Safety footwear having direct molding sole.
IS: 5983 – 1978	Eye protectors.
IS: 9167 – 1979	Ear protectors.
IS: 1179-1967	Eye & Face protection during welding
IS: 3521 – 1983	Industrial Safety Belts and Harness
IS:8519 -1977	Guide for selection of industrial Safety equipment for body protection
IS:9473-2002,14166-1994,14746-1999	Respiratory Protective Devices

The list is not exhaustive. The safety officer may demand additional PPEs based on specific requirement.

- Where workers are employed in sewers and manholes, which are in use, the subcontractor shall ensure that the manhole covers are opened and ventilated at least for an hour before the workers are allowed to get into manhole, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent incident to the public
- Besides the PPEs mentioned above, the persons shall use helmet and safety shoe. The visitors shall use Helmet and any other PPEs as deemed appropriate for the area of work.

Colour scheme for Helmets:

1. Workmen: Yellow
2. Safety staff: Green or white with green band
3. Electrician: Red
4. Others including visitors: White

- All the PPEs shall be checked for its quality before issue and the same shall be periodically checked. The users shall be advised to check the PPEs themselves for any defect before putting on. The defective ones shall be repaired/ replaced.
- The issuing agency shall maintain register for issue and receipt of PPEs.
- The Helmets shall have logo or name (abbreviation of agency name permitted) affixed or printed on the front.
- The body harnesses shall be serial numbered.

8.4 ARRANGEMENT OF INFRASTRUCTURE

8.4.1 DRINKING WATER

- Drinking water shall be provided and maintained at suitable places at different elevations.
- Container should be labeled as " Drinking Water"
- Cleaning of the storage tank shall be ensured atleast once in 3 months indicating date of cleaning and next due date.
- Potability of water should be tested as per IS10500 at least once in a year.

8.4.2 WASHING FACILITIES

- In every workplace, adequate and suitable facilities for washing shall be provided and maintained.
- Separate and adequate cleaning facilities shall be provided for the use of male and female workers. Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition and dully illuminated for night use.
- Overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the painters and other workers to wash during the cessation of work.

8.4.3 LATRINES AND URINALS

- Latrines and urinals shall be provided in every work place.
- Urinals shall also be provided at different elevations.
- They shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times, by appointing designated person.
- Separate facilities shall be provided for the use of male and female worker if any.

8.4.4 PROVISION OF SHELTER DURING REST

Proper Shed & Shelter shall be provided for rest during break

8.4.5 MEDICAL FACILITIES

8.4.5.1 MEDICAL CENTRE (As per Schedule V, X and XI of BOCW central Rules, 1998)

- A medical centre shall be ensured/identified at site with basic facilities for handling medical emergencies. The medical center can be jointly developed on proportionate sharing basis with permission from BHEL
- A qualified medical professional, not less than MBBS, shall be deployed at the medical centre
- The medical centre shall be equipped with one ambulance, with trained driver and oxygen cylinder.
- Medical waste shall be disposed as per prevailing legislation (Bio-Medical Waste –Management and Handling Rules, 1998)

8.4.5.2 FIRST AIDER

- Ensure availability of Qualified First-aider throughout the working hours.
- Every injury shall be treated, recorded and reported.
- Refresher course on first aid shall be conducted as necessary.
- List of Qualified first aiders and their contact numbers should be displayed at conspicuous places.

8.4.5.3 FIRST AID BOX (as per schedule III of BOCW)

- The subcontractor shall provide necessary first aid facilities as per schedule III of BOCW. At every work place first aid facilities shall be provided and maintained.
- The first aid box shall be kept by first aider who shall always be readily available during the working hours of the work place. His name and contact no to be displayed on the box.
- The first aid boxes should be placed at various elevations so as to make them available within the reach and at the quickest possible time.
- The first aid box shall be distinctly marked with a Green Cross on white background.
- Details of contents of first aid box is given in Annexure No. 01
- Monthly inspection of First Aid Box shall be carried out by the owner as per format no. HSEP:14-F01
- The subcontractor should conduct periodical first –aid classes to keep his supervisor and Engineers properly trained for attending to any emergency.

8.4.5.4 HEALTH CHECK UP (As per schedule VII and Form XI)

The persons engaged at the site shall undergo health checkup as per the format no. HSEP:14-F02 before induction. The persons engaged in the following works shall undergo health checkup at least once in a year:

a. Height workers
b. Drivers/crane operators/riggers

c. Confined space workers
d. Shot/sand blaster
e. Welding and NDE personnel

8.4.6 PROVISION OF CANTEEN FACILITY

- Canteen facilities shall be provided for the workmen of the project inside the project site.
- Proper cleaning and hygienic condition shall be maintained.
- Proper care should be taken to prevent biological contamination.
- Adequate drinking water should be available at canteen.
- Fire extinguisher shall be provided inside canteen.
- Regular health check-up and medication to the canteen workers shall be ensured.

8.4.7 PROVISION OF ACCOMODATION/LABOUR COLONY

- The subcontractor shall arrange for the accommodation of workmen at nearby localities or by making a labour colony.
- Regular housekeeping of the labour colony shall be ensured.
- Proper sanitation and hygienic conditions to be maintained.
- Drinking water and electricity to be provided at the labour colony.
- Bathing/ washing bay
- Room ventilation and electrification.

8.4.8 PROVISION OF EMERGENCY VEHICLE

- Dedicated emergency vehicle shall be made available at workplace by each subcontractor to handle any emergency

8.4.9 PEST CONTROL

Regular pest control should be carried out at all offices, mainly laboratories, canteen, labour colony and stores.

8.4.10 SCRAPYARD

- In consultation with customer, scrapyard shall be developed to store metal scrap, wooden scrap, waste, hazardous waste.
- Scrap/Waste shall be segregated as Bio-degradable and non-bio-degradable and stored separately.

8.4.11 ILLUMINATION

- The subcontractor shall arrange at his cost adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. at various levels for safe and proper working operations at dark places and during night hours at the work spot as well as at the pre-assembly area.

- Adequate and suitable light shall be provided at all work places & their approaches including passage ways as per IS: 3646 (Part-II). Some recommended values are given below:

S. No.	Location	Illumination (Lux)
A.	**Construction Area**	
1.	Outdoor areas like store yards, entrance and exit roads	20
2.	Platforms	50
3.	Entrances, corridors and stairs	100
4.	General illumination of work area	150
5.	Rough work like fabrication, assembly of major items	150
6.	Medium work like assembly of small machined parts rough measurements etc.	300
7.	Fine work like precision assembly, precision measurements etc.	700
8.	Sheet metal works	200
9.	Electrical and instrument labs	450
B.	**Office**	
1.	Outdoor area like entrance and exit roads	20
2.	Entrance halls	150
3.	Corridors and lift cars	70
4.	Lift landing	150
5.	Stairs	100
6.	Office rooms, conference rooms, library reading tables	300
7.	Drawing table	450
8.	Manual telephone exchange	200

- Lamp (hand held) shall not be powered by mains supply but either by 24V or dry cells.
- Lamps shall be protected by suitable guards where necessary to prevent danger, in case of breakage of lamp.
- Emergency lighting provision for night work shall be made to minimise danger in case of main supply failure.

If the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instructions issued by the authorized BHEL official, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor

9.0 HSE TRAINING& AWARENESS

9.1 HSE INDUCTION TRAINING

All persons entering into project site shall be given HSE induction training by the HSE officer of BHEL /subcontractor before being assigned to work.

In-house induction training subjects shall include but not limited to:

- Briefing of the Project details.
- Safety objectives and targets.
- Site HSE rules.
- Site HSE hazards and aspects.
- First aid facility.
- Emergency Contact No.
- Incident reporting.
- Fire prevention and emergency response.
- Rules to be followed in the labour colony (if applicable)

- Proper safety wear & gear must be issued to all the workers being registered for the induction (i.e., Shoes/Helmets/Goggles/Leg guard/Apron etc.)
- They must arrive fully dressed in safety wear & gear to attend the induction.
- Any one failing to conform to this safety wear& gear requirement shall not qualify to attend.
- On completing attending subcontractor's in-house HSE induction, each employee shall sign an induction training form (format no. HSEP:14-F03) to declare that he had understood the content and shall abide to follow and comply with safe work practices. They may only then be qualified to be issued with a personal I.D. card, for access to the work site.

9.2 HSE TOOLBOX TALK

- HSE tool Box talk shall be conducted by frontline foreman/supervisor of subcontractor to specific work groups prior to the start of work. The agenda shall consist of the followings:
    - Details of the job being intended for immediate execution.
    - The relevant hazards and risks involved in executing the job and their control and mitigating measures.
    - Specific site condition to be considered while executing the job like high temperature, humidity, unfavorable weather etc.
    - Recent non-compliances observed.
    - Appreciation of good work done by any person.
    - Any doubt clearing session at the end.
- Record of Tool box talk shall be maintained as per format no. HSEP:14-F04
- Tool box talk to be conducted at least once a week for the specific work.

9.3 TRAINING ON HEIGHT WORK

Training on height work shall be imparted to all workers working at height by in-house/external faculty at least twice in a year. The training shall include following topics:

- Use of PPEs
- Use of fall arrester, retractable fall arrester, life line, safety nets etc.
- Safe climbing through monkey ladders.
- Inspection of PPEs.
- Medical fitness requirements.
- Mock drill on rescue at height.
- Dos & Don'ts during height work.

9.4 HSE TRAINING DURING PROJECT EXECUTION

- Other HSE training shall be arranged by BHEL/ subcontractor as per the need of the project execution and recommendation of HSE committee of site.
- The topics of the HSE training shall be as follows but not limited to:
    - Hazards identification and risk analysis (HIRA)
    - Work Permit System
    - Incident investigation and reporting
    - Fire fighting
    - First aid
    - Fire-warden training
    - EMS and OHSMS
    - T & Ps fitness and operation

- Electrical safety
- Welding, NDE & Radiological safety
- Storage, preservation & material handling.

- A matrix shall be maintained to keep an up-to-date record of attendance of training sessions carried out.

9.5 HSE PROMOTION-SIGNAGE, POSTERS, COMPETITION, AWARDS ETC

9.5.1 Display of HSE posters and banners

- Site shall arrange appropriate posters, banners, slogans in local/Hindi/English languages at work place

9.5.2 Display of HSE signage

- Appropriate HSE signage shall be displayed at the work area to aware workmen and passersby about the work going on and do's and don'ts to be followed

9.5.3 Competition on HSE and award

- Site will arrange different competition (slogan, poster, essay etc.) on HSE time to time (Safety day, BHEL day, World Environment Day etc.) and winners will be suitably awarded.

9.5.4 HSE awareness programme

- Subcontractor shall arrange HSE awareness programme periodically on different topics including medical awareness for all personnel working at site

10.0 HSE COMMUNICATION

10.1 INCIDENT REPORTING

- The subcontractor shall submit report of all incidents, fires and property damage etc to the Engineer immediately after such occurrence, but in any case not later than 24 hours of the occurrence. Such reports shall be furnished in the manner prescribed by BHEL. (Refer HSE procedure for incident investigation, analysis and reporting for details)
- In addition, periodic reports on safety shall also be submitted by the subcontractor to BHEL from time to time as prescribed by the Engineer. Compiled monthly reports of all kinds of incidents, fire and property damage to be submitted to BHEL safety officer as per prescribed formats.
- HSE incidents of site shall be reported to BHEL site Management as per Procedure for Incident Investigation and Reporting in format no. HSEP:14-F15. Corrective action shall be immediately implemented at the work place and compliance shall be verified by BHEL HSE officer and until then, work shall be put on hold by Construction Manager.

10.2 HSE EVENT REPORTING

- Important HSE events like HSE training, Medical camp etc. organized at site shall be reported to BHEL site management in detail with photographs for publication in different in-house magazines
- Celebration of important days like National Safety Day, World Environment Day etc. shall also be reported as mentioned above.

10.3 DAILY HSE ACTIVITY REPORTING

Daily HSE activities shall be reported by subcontractor to BHEL as per Format No. HSEP:14-F31A

11.0 OPERATIONAL CONTROL

All applicable OCPs (Operational control procedures) will be followed by subcontractor as per BHEL instructions. This will be done as part of normal scope of work. List of such OCPs is given below. In case any other OCP is found to be applicable during the execution of work at site, then subcontractor will follow this as well, within quoted rate. These OCPs (applicable ones) will be made available to subcontractor during work execution at site. However for reference purpose, these are kept with Safety Officer of BHEL at the Power Sector Regional HQ, or available in downloadable format in the website, which may be refereed by subcontractor, if they so desire.

LIST OF OCPs

Safe handling of chemicals	Safety in use of cranes	Hydraulic test
Electrical safety	Storage and handling of gas cylinders	Spray insulation
Energy conservation	Manual arc welding	Trial run of rotary equipment
Safe welding and gas cutting operation	Safe use of helmets	Stress relieving
Fire safety	Good house keeping	Material preservation
Safety in use of hand tools	Working at height	Cable laying/tray work
First aid	Safe excavation	Transformer charging
Food safety at canteen	Safe filling of hydrogen in cylinder	Electrical maintenance
Illumination	Vehicle maintenance	Safe handling of battery system
Handling and erection of heavy metals	Safe radiography	Computer operation
Safe acid cleaning	Waste disposal	Storage in open yard
Safe alkali boil out	Working at night	For sanitary maintenance
Safe oil flushing	Blasting	Batching
Steam blowing	DG set	Piling rig operation
Safe working in confined area	Handling & storage of mineral wool	Gas distribution test
Safe operation of passenger lift, material hoists & cages	Drilling, reaming and grinding(machining)	Cleaning of hotwell / deaerator
Electro-resistance heating	Compressor operation	O&M of control of AC plant & system
Air compressor	Passivation	Safe Loading of Unit
Safe EDTA Cleaning	Safe Chemical cleaning of Pre boiler system	Safe Boiler Light up
Safe Rolling and Synchronization		

11.1 HSE ACTIVITIES

HSE activities shall be conducted at site based on the HSEMSM developed by Power Sector and issued to site by Regions.
While planning for any activity the following documents shall be referred for infrastructural requirements to establish control measures:

1) HSE Procedure for Register of OHS Hazards and Risks
2) HSE Procedure for Register of Environmental Aspects and Impacts
3) HSE Procedure for Register of Regulations

4) Operational Control Procedures
5) HSE Procedure for Emergency Preparedness and Response Plan
6) Contract documents

11.2 WORK PERMIT SYSTEM

- The following activities shall come under Work Permit System
  a. Height working above 2 metres
  b. Hot working at height
  c. Confined space
  d. Radiography
  e. Excavation more than 4 meter depth
  f. Heavy lifting above 50 ton
  Refer Annexure 05 for Work permit formats.
- "HSE Procedure for Work Permit System" shall be followed while implementing permit system. Where customer is having separate Work Permit System the same shall be followed.
- Permit applicant shall apply for work permit of particular work activity at particular location before starting of the work with Job Hazard Analysis.
- Permit signatory shall check that all the control measures necessary for the activity are in place and issue the permit to the permit holder.
- Permit holder shall implement and maintain all control measures during the period of permit .He will close the permit after completion of the work. The closed permit shall be archived in HSE Department of site.

11.3 SAFETY DURING WORK EXECUTION

Respective OCPS are to be followed and adherence to the same would be contractually binding

11.3.1 WELDING SAFETY

All safety precautions shall be taken for welding and cutting operations as per IS-818. All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.

11.3.2 RIGGING

Rigging equipment shall not be loaded in excess of its recommended safe working load. Rigging equipment, when not in use, shall be removed from the original work area so as not to present a hazard to employees.

11.3.3 CYLINDERS STORAGE AND MOVEMENT

All gas cylinders shall be stored in upright position. Suitable trolley shall be used. There shall be flash-back arrestors conforming to IS-11006 at both cylinder and burner ends. Damaged tube and regulators must be immediately replaced. No of cylinders shall not exceed the specified quantity as per OCP
Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally dragged, struck or permitted to strike each other violently.

When cylinders are transported by powered vehicle they shall be secured in a vertical position.

11.3.4 DEMOLITION WORK

Before any demolition work is commenced and also during the process of the work the following shall be ensured:

- All roads and open areas adjacent to the work site shall either be closed or suitably protected.
- No electric cable or apparatus which is liable to be a source of danger nor a cable or an apparatus used by the operator shall remain electrically charged.
- All practical steps shall be taken to prevent danger to persons employed from the risks of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render them unsafe.

11.3.5 T&Ps

All T&Ps/ MMEs should be of reputed brand/appropriate quality & must have valid test/calibration certificates bearing endorsement from competent authority of BHEL..Subcontractor to also submit monthly reports of T&Ps deployed and validity test certificates to BHEL safety Officer as per the format/procedure of BHEL.

11.3.6 CHEMICAL HANDLING

Displaying safe handling procedures for all chemicals such as lube oil, acid, alkali, sealing compounds etc , at work place.Where it is necessary to provide and/or store petroleum products or petroleum mixture & explosives, the subcontractor shall be responsible for carrying out such provision / storage in accordance with the rules & regulations laid down in the relevant petroleum act, explosive act and petroleum and carbide of calcium manual, published by the chief inspector of explosives of India. All such storage shall have prior approval if necessary from the chief inspector of explosives or any other statutory authority. The subcontractor shall be responsible for obtaining the same.

11.3.7 ELECTRICAL SAFETY

- Providing adequate no. of 24 V sources and ensure that no hand lamps are operating at voltage level above 24 Volts.
- Fulfilling safety requirements at all power tapping points.
- High/ Low pressure welders to be identified with separate colour clothings. No welders will be deployed without passing appropriate tests and holding valid welding certificates. Approved welding procedure should be displayed at work place.
- The subcontractor shall not use any hand lamp energized by Electric power with supply voltage of more than 24 volts in confined spaces like inside water boxes, turbine casings, condensers etc.
- All portable electric tools used by the subcontractor shall have safe plugging system to source of power and be appropriately earthed. Only electricians licensed by appropriate statutory authority shall be employed by the subcontractor to carry out all types of electrical works. Details of earth resource ad their test date to be given to BHEL safety officer as per the prescribed formats of BHEL
- The subcontractor shall use only properly insulated and armored cables which conform to the requirement of Indian Electricity Act and Rules for all wiring, electrical applications at site.

- BHEL reserves the right to replace any unsafe electrical installations, wiring, cabling etc. at the cost of the subcontractor.
- All electrical appliances used in the work shall be in good working condition and shall be properly earthed.
- No maintenance work shall be carried out on live equipment.
- The subcontractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installations.
- Area wise Electrical safety inspection is to be carried out on monthly basis as per "Electrical Safety Inspection checklist' and the report is to be submitted to BHEL safety officer
- Adequate precautions shall be taken to prevent danger for electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public
- The subcontractor shall carefully follow the safety requirement of BHEL/ the purchaser with the regard to voltages used in critical areas.

11.3.8 FIRE SAFETY

- Providing appropriate fire fighting equipment at designated work place and nominate a fire officer/warden adequately trained for his job.
- Subcontractor shall provide enough fire protecting equipment of the types and numbers at his office, stores, temporary structure in labor colony etc. Such fire protection equipment shall be easy and kept open at all times.
- The fire extinguishers shall be properly refilled and kept ready which should be certified at periodic intervals. The date of changing should be marked on the Cylinders.
- All other fire safety measures as laid down in the "codes for fire safety at construction site" issued by safety coordinator of BHEL shall be followed.
- Non-compliance of the above requirement under fire protection shall in no way relieve the subcontractor of any of his responsibility and liabilities to fire incident occurring either to his materials or equipment or those of others.
- Emergency contacts nos must be displayed at prominent locations
- Tarpaulin being inflammable should not be used (instead, only non-infusible covering materials shall be used) as protective cover while preheating, welding, stress relieving etc. at site.

11.3.9 SCAFFOLDING

- Suitable scaffolds shall be provided for workman for all works that cannot safely be done from the ground, or from solid construction except in the case of short duration of work which can be done safely from ladders.
- When a ladder is used, it shall be of rigid construction made of steel. The steps shall have a minimum width of 45 cm and a maximum rise of 30 cm. Suitable handholds of good quality wood or steel shall be provided and the ladder shall be given an inclination not steeper then ¼ horizontal and 1 vertical.
- Scaffolding or staging more than 3.6 m above the ground floor, swung or suspended from an overhead support or erected with stationery support shall have a guard rail properly bolted, braced or otherwise secured, at least 90 cm above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from saver, from swaying, from the building or structure.

11.3.10 **WORK AT HEIGHT**:

- Guardrails and toe-board/barricades and sound platform conforming to IS:4912-1978 should be provided.

- Wherever necessary, life-line (pp or metallic) and fall arrestor along with Polyamide rope or Retractable lifeline should be provided.
- Safety Net as per IS:11057:1984 should be used extensively for prevention/ arrest of men and materials falling from height. The safety nets shall be fire resistant, duly tested and shall be of ISI marked and the nets shall be located as per site requirements to arrest or to reduce the consequences of a possible fall of persons working at different heights.
- Reaching beyond barricaded area without lifeline support, moving with support of bracings, walking on beams without support, jumping from one level to another, throwing objects and taking shortcut must be discouraged.
- Use of Rebar steel for making Jhoola and monkey-ladder (Rods welded to vertical or inclined structural members), temporary platform etc. must be avoided.
- Monkey Ladder should be properly made and fitted with cages.
- Jhoola should be made with angles and flats and tested like any lifting tools before use.
- Lanyard must be anchored always and in case of double lanyard, each should be anchored separately.
- In case of pipe-rack, persons should not walk on pipes and walk on platforms only.
- In case of roof work, walking ladder/ platform should be provided along with lifeline and/ or fall arrestor.
- Empty drums must not be used.
- For chimney or structure painting, both hanging platform and men should be anchored separately to a firm structure along with separate fall arrestor. Rope ladder should be discouraged.

11.3.11 WORKING PLATFORM

Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform gangways provided is more than 3.6 m above ground level or floor level, they shall be closely boarded and shall have adequate width which shall not be less than 750 mm and be suitably fenced as described above. Every opening in the floor or a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 90 cm.

11.3.12 EXCAVATION

Wherever there are open excavation in ground, they shall be fenced off by suitable railing and danger signals installed at night so as to prevent persons slipping into the excavations.

11.3.13 LADDER SAFETY

Safe means of access shall be provided to all working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m in the length while the width between side rails in rung ladder shall in no case be less than app. 29.2 cm for ladder upto and including 3 m in length. For longer ladders this width shall be increased at least ¼'' for each additional foot of length.

A sketch of the ladders and scaffolds proposed to be used shall be prepared and approval of the Engineer obtained prior to Construction.

11.3.14 LIFTING SAFETY

- It will be the responsibility of the subcontractor to ensure safe lifting of the equipment, taking due precaution to avoid any incident and damage to other equipment and personnel.

- All requisite tests and inspection of handling equipment, tools & tackle shall be periodically done by the subcontractor by engaging only the Competent Persons as per law.
- Defective equipment or uncertified shall be removed from service.
- Any equipment shall not be loaded in excess of its recommended safe working load.

11.3.15 HOISTING APPLIANCE

- Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards.
- Hoisting appliance should be provided with such means as will reduce to the minimum the risk of any part of a suspended load becoming incidentally displaced.
- When workers employed on electrical installations which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots as may be necessary should be provided.
- The worker should not wear any rings, watches and carry keys or other materials which are good conductor of electricity.

11.4 ENVIRONMENTAL CONTROL

Environment protection has always been given prime importance by BHEL. Environmental damage is a major concern of the principal subcontractor and every effort shall be made, to have effective control measures in place to avoid pollution of Air, Water and Land and associated life. Chlorofluorocarbons such as carbon tetrachloride and trichloroethylene shall not be used. Waste disposal shall be done in accordance with the guidelines laid down in the project specification.

Any chemical including solvents and paints, required for construction shall be stored in designated bonded areas around the site as per Material Safety Data Sheet (MSDS).

In the event of any spillage, the principle is to recover as much material as possible before it enters drainage system and to take all possible action to prevent spilled materials from running off the site. The subcontractor shall use appropriate MSDS for clean-up technique

All subcontractors shall be responsible for the cleanliness of their own areas.

The subcontractors shall ensure that noise levels generated by plant or machinery are as low as reasonably practicable. Where the subcontractor anticipates the generation of excessive noise levels from his operations the subcontractor shall inform to Construction Manager of BHEL accordingly so that reasonable &practicable precautions can be taken to protect other persons who may be affected.
It is imperative on the part of the subcontractor to join and effectively contribute in joint measures such as tree plantation, environment protection, contributing towards social upliftment, conversion of packing woods to school furniture, keeping good relation with local populace etc.
The subcontractor shall carry out periodic air and water quality check and illumination level checking in his area of work place and take suitable control measure.

11.5 HOUSEKEEPING

- Keeping the work area clean/ free from debris, removed scaffoldings, scraps, insulation/sheeting wastage /cut pieces, temporary structures, packing woods etc. will be in the scope of the subcontractor. Such cleanings has to be done by

subcontractor within quoted rate, on daily basis by an identified group. If such activity is not carried out by subcontractor / BHEL is not satisfied, then BHEL may get it done by other agency and actual cost along with BHEL overheads will be deducted from contractor's bill. Such decisions of BHEL shall be binding on the subcontractor

- Proper housekeeping to be maintained at work place and the following are to be taken care of on daily basis.
- All surplus earth and debris are removed/disposed off from the working areas to identified locations.
- Unused/Surplus cables, steel items and steel scrap lying scattered at different places/elevation within the working areas are removed to identified locations.
- All wooden scrap, empty wooden cable drums and other combustible packing materials, shall be removed from workplace to identified locations. Sufficient waste bins shall be provided at
- Different work places for easy collection of scrap/waste. Scrap chute shall be installed to remove scrap from high location.
- Access and egress (stair case, gangways, ladders etc.) path should be free from all scrap and other hindrances.
- Workmen shall be educated through tool box talk about the importance of housekeeping and encourage not to litter.
- Labour camp area shall be kept clear and materials like pipes, steel, sand, concrete, chips and bricks, etc. shall not be allowed in the camp to obstruct free movement of men and machineries.
- Fabricated steel structures, pipes & piping materials shall be stacked properly.
- No parking of trucks/trolleys, cranes and trailers etc. shall be allowed in the camp, which may obstruct the traffic movement as well as below LT/HT power line.
- Utmost care shall be taken to ensure over all cleanliness and proper upkeep of the working areas

11.6 WASTE MANAGEMENT

Take suitable measures for waste management and environment related laws/legislation as a part of normal construction activities. Compliance with the legal requirements on storage/ disposal of paint drums (including the empty ones), Lubricant containers, Chemical Containers, and transportation and storage of hazardous chemicals will be strictly maintained.

11.6.1 BINS AT WORK PLACE

- Sufficient rubbish bins shall be provided close to workplaces.
- Bins should be painted yellow and numbered.
- Sufficient nos. of drip trays shall be provided to collect oil and grease.
- Sufficient qty. of broomsticks with handle shall be provided.
- Adequate strength of employees should be deployed to ensure daily monitoring and service for waste management.

11.6.2 STORAGE AND COLLECTION

- Different types of rubbish/waste should be collected and stored separately.
- Paper, oily rags, smoking material, flammable, metal pieces should be collected in separate bins with close fitting lids.
- Rubbish should not be left or allowed to accumulate on construction and other work places.
- Do not burn construction rubbish near working site.

11.6.3 SEGREGATION

- Earmark the scrap area for different types of waste.
- Store wastes away from building.
- Oil spill absorbed by non-combustible absorbent should be kept in separate bin.
- Clinical and first aid waste stored and incinerated separately.

11.6.4 DISPOSAL

- Sufficient containers and scrap disposal area should be allocated.
- All scrap bin and containers should be conveniently located.
- Provide self-closing containers for flammable/spontaneously combustible material.
- Keep drainage channels free from choking.
- Make schedule for collection and disposal of waste.

11.6.5 WARNING AND SIGNS

- Appropriate sign to be displayed at scrap storage area
- No toxic, corrosive or flammable substance to be discarded into public sewage system.
- Waste disposal shall be in accordance with best practice.
- Comply with all the requirements of Pollution Control Board (PCB) for storage and disposal of hazardous waste.

11.7 TRAFFIC MANAGEMENT SYSTEM

11.7.1 SAFE WORKPLACE TRANSPORT SYSTEM

- Traffic routes in a work place shall be suitable for the persons or vehicles using them. This shall be sufficient in number and of sufficient size. This shall reflect the suitability of traffic routes for vehicles and pedestrians.
- Where vehicles and pedestrians use the same traffic routes there shall be sufficient space between them. Where necessary all traffic routes must be suitably indicated. Pedestrians or vehicles must be able to use traffic routes without endangering those at work. There must be sufficient separation of traffic routes from doors, gates and pedestrian traffic routes.
- For internal traffic, lines marked on roads / access routes and between buildings shall clearly indicate where vehicles are to pass.
- Temporary obstacles shall be brought to the attention of drivers by warning signs or hazard cones.
- Speed limits shall be clearly displayed. Speed ramps preceded by a warning signs or marker are necessary.
- The traffic route should be wide enough to allow vehicles to pass and re-pass oncoming or parked traffic and it may be advisable to introduce on-way system or parking restrictions.
- Safest route shall be provided between places where vehicles have to call or deliver.
- Avoid vulnerable areas/items such as fuel or chemicals tanks or pipes, open or unprotected edges and structures likely to collapse

- Safe areas shall be provided for loading and unloading.
- Avoid sharp or blind bends. If this is not possible hazards should be indicated e.g. blind corner.
- Ensure road crossings are minimum and clearly signed.
- Entrance and gateways shall be wide enough to accommodate a second vehicle without causing obstruction.
- Set sensible speed limits which are clearly sign posted.
- Where necessary ramps should be used to retard speed. This shall be preceded by a warning sign or mark on the road.
- Forklift trucks shall not pass over road hump unless of a type capable of doing so.
- Overhead electric cable, pipes containing flammable hazardous chemical shall be shielded by using goal posts height gauge posts or barriers.
- Road traffic signs shall be provided on prominent locations for prevention of incidents and hazards and for quick guidance and warning to employees and public. Safety signs shall be displayed as per the project working requirement and guideline of the state in which project is done. Vehicles hired or used shall not be parked within the 15m radius of any working area. Any vehicle, that is required to be at the immediate/near the vicinity, shall be approved by the person in-charge of the site.

11.7.2 TRAFFIC ROUTE FOR PEDESTRIANS

- Where traffic routes are used by both pedestrians and vehicles road shall be wide enough to allow vehicles and pedestrians safely.
- Separate routes shall be provided for pedestrians to keep them away from vehicles. Provide suitable barriers/guard at entrances/exit and the corners or buildings.
- Where pedestrian and vehicle routes cross, appropriate crossing shall be provided.
- Where crowd is likely to use roadway e.g. at the end of shift, stop vehicles from using them at such times.
- Provide high visibility clothing for people permitted in delivery area.

11.7.3 WORK VEHICLE

Work vehicle shall be as safe stable efficient and roadworthy as private vehicles on public roads. Site management shall ensure that drivers are suitably trained. All vehicle e.g. heavy motor vehicle forklift trucks dump trucks mobile cranes shall ensure that the work equipment conforms to the following:

- A high level of stability.
- A safe means of access/egress.
- Suitable and effective service and parking brakes.
- Windscreens with wipers and external mirrors giving optimum all round visibility.
- Provision of horn, vehicle lights, reflectors, reversing lights, reversing alarms.
- Provision of seat belts.
- Guards on dangerous parts.
- Driver protection - to prevent injury from overturning and from falling objects/materials.
- Driver protection from adverse weather.
- No vehicle shall be parked below HT/LT power lines.
- Valid Pollution Under Control certification for all vehicles

11.7.4 DAILY CHECK BY DRIVER

- There should also be daily safety checks containing below mentioned points by the driver before the vehicle is used.
  - Brakes.
  - Tires.
  - Steering.
  - Mirrors.
  - Windscreen waters.
  - Wipers.
  - Warning signals.
  - Specific safety system i.e. control interlocks
- Management should ensure that drivers carry out these checks.

11.7.5 TRANSPORTATION OF PERSONNEL AND MATERIALS BY VEHICLES

- All drivers shall hold a valid driving License for the class of vehicle to be driven and be registered as an authorized BHEL driver with the Administration Department.
- Securing of the load shall be by established and approved methods, i.e. chains with patented tightening equipment for steel/heavy loads. Sharp corners on loads shall be avoided when employing ropes for securing.
- All overhangs shall be made clearly visible and restricted to acceptable limits
- Load shall be checked before moving off and after traveling a suitable distance.
- On no account is construction site to be blocked by parked vehicles Drivers of vehicles shall only stop or park in the areas designate by the stringing foreman.
- Warning signs shall be displayed during transportation of material.
  All vehicles used by BHEL shall be in worthy condition and in conformance to the Land Transport requirement.

11.7.6 MAINTENANCE

All Vehicles used for transportation of man and material shall undergo scheduled inspections on frequent intervals to secure safe operation. Such inspections shall be conducted in particular for steering, brakes, lights, horn, doors etc. Site management shall ensure that work equipment is maintained in an efficient, working order and in good repair. Inspections and services carried out at regular intervals of time and or mileage. No maintenance shall be carried below HT/LT power lines.

11.8 EMERGENCY PREPAREDNESS AND RESPONSE

- Emergency preparedness and response capability of site shall be developed as per Emergency Preparedness and Response plan issued by Regional HQ
- Availability of adequate number of first aiders and fire warden shall be ensured with BHEL and its subcontractors
- All the subcontractor's supervisory personnel and sufficient number of workers shall be trained for fire protection systems. Enough number of such trained personnel must be available during the tenure of contract. Subcontractor should nominate his supervisor to coordinate and implement the safety measures.
- Assembly point shall be earmarked and access to the same from different location shall be shown
- Fire exit shall be identified and pathway shall be clear for emergency escape.

- Appropriate type and number of fire extinguisher shall be deployed as per Fire extinguisher deployment plan and validity shall be ensured periodically through inspection
- Adequate number of first aid boxes shall be strategically placed at different work places to cater emergency need. Holder of the first aid box shall be identified on the box itself who will have the responsibility to maintain the same.
- First aid center shall be developed at site with trained medical personnel and ambulance
- Emergency contact numbers (format given in EPRP) of the site shall be displayed at prominent locations.
- Tie up with fire brigade shall be done in case customer is not having fire station.
- Tie up with hospital shall be done in case customer is not having hospital.
- Disaster Management group shall be formed at site
- Mock drill shall be arranged at regular intervals. Monthly report of the above to be given to BHEL safety Officer as per prescribed BHEL formats
- Mock drill shall be conducted on different emergencies periodically to find out gaps in emergency preparedness and taking necessary corrective action

12.0 HSE INSPECTION

Inspection on HSE for different activities being carried out at site shall be done to ensure compliance to HSEMS requirements. The subcontractor shall maintain and ensure necessary safety measures as required for inspection and tests HV test, Pneumatic test, Hydraulic test, Spring test, Bend test etc. as applicable, to enable inspection agency for performing Inspection. If any test equipment is found not complying with proper safety requirements then the Inspection Agency may withhold inspection, till such time the desired safety requirements are met.

12.1 DAILY HSE CHECKS

Both the Site Supervisors and safety officer of Subcontractor are to conduct daily site Safety inspection around work activities and premises to ensure that work methods and the sites are maintained to an acceptable standard. The following are to form the common subjects of a daily safety inspection:

- Personal Safety wears & gear compliance.
- Complying with site safety rules and permit-to-work (PTW).
- Positions and postures of workers.
- Use of tools and equipment etc. by the workers.

The inspection should be carried out just when work starts in beginning of the day, during peak activities period of the day and just before the day's work ends.

12.2 INSPECTION OF PPE

- PPEs shall be inspected by HSE officer at random once in a week as per format no. HSEP:14-F06 for its compliance to standard and compliance to use and any adverse observation shall be recorded in the PPE register.
- The applicable PPEs for carrying out particular activities are listed below.

12.3 INSPECTION OF T&Ps

- A master list of T&Ps shall be maintained by each subcontractor.
- All T&Ps being used at site shall be inspected by HSE officer once in a month as per format no. HSEP:14-F07 for its healthiness and maintenance.
- The T&Ps which require third party inspection shall be checked for its validity during inspection. The third party test certificate should be accompanied with a copy of the concerned competent person's valid qualification record.
- The validity of T&P shall be monitored as per "Status of T&Ps" format no. HSEP:14-F08

12.4 INSPECTION OF CRANES AND WINCHES

- Cranes and winches shall be inspected by the operator through a daily checklist for its safe condition (as provided by the equipment manufacturer) before first use of the day.
- Cranes and Winches shall be inspected by HSE officer once in a month as per format no. HSEP:14-F09 for healthiness, maintenance and validity of third party inspection.
- The date of third party inspection and next due date shall be painted on cranes and winches.
- The operators/drivers shall be authorized by sub-contractor based on their competency and experience and shall carry the I-card.
- The operator should be above 18 years of age and should be in possession of driving license of HMV man & goods), vision test certificate and should have minimum qualification so that he can read the instructions and check list.

12.5 INSPECTION ON HEIGHT WORKING

- Inspection on height working shall be conducted daily by supervisors before start of work to ensure safe working condition including provision of
    - Fall arrestor
    - Lifelines
    - Safety nets
    - Fencing and barricading
    - Warning signage
    - Covering of opening
    - Proper scaffolding with access and egress.
    - Illumination
- Inspection on height working shall be conducted once in a week by HSE officer as per format no. HSEP:14-F10.
- Medical fitness of height worker shall be ensured.
- Height working shall not be allowed during adverse weather.

12.6 INSPECTION ON WELDING AND GAS CUTTING OPERATION

- Supervisor shall ensure that no flammable items are available in near vicinity during welding and gas cutting activity.
- Gas cylinders shall be kept upright.
- Use of Flash back arrestor shall be ensured at both ends.

- Inspection during welding and gas cutting operations shall be carried out by HSE officer once a month as per format no. HSEP:14-F11.
- Use of fire blanket to be ensured to avoid falling of splatters during welding or gas cutting operation at height.
- Availability of fire extinguisher at vicinity shall be ensured.

12.7 INSPECTION ON ELECTRICAL INSTALLATION / APPLIANCES

- Ensure proper earthing in electrical installation
- Use ELCB at electrical booth
- Electrical installation shall be properly covered at top where required
- Use appropriate PPEs while working
- Use portable electrical light < 24 V in confined space and potentially wet area.
- Monthly inspection shall be carried out as per format no. HSEP:14-F12.

12.8 INSPECTION OF ELEVATOR

- Elevators shall be inspected by concerned supervisors once in a week as per format no. HSEP:14-F13.
- All elevators shall be inspected by competent person and validity shall be ensured.
- The date of third party inspection and next due date shall be painted on elevator.

12.9 INSPECTION OF EXCAVATION

Excavation activities shall be inspected as per Format HSEP:14-F13A

13.0 HSE PERFORMANCE

- Contractor shall be assessed on monthly basis for HSE Compliance by BHEL Safety In-charge at site.
  The HSE compliance shall be based on Online HSE Evaluation System of BHEL as per Format No. HSEP:14-F33.
- BHEL shall reserve the right to use this assessment for evaluating bidder's capacity for future tenders
- Suitable HSE reward system shall be developed at site level to promote HSE compliance amongst workmen by the subcontractor.
  To decide HSE reward, performance towards HSE shall be evaluated for workmen and it shall be awarded regularly in public gathering.
- If safety record of the subcontractor in execution of the awarded job is to the satisfaction of safety department of BHEL, issue of an appropriate certificate to recognize the safety performance of the subcontractor may be considered by BHEL after completion of the job.

14.0 HSE PENALTIES

- As per contractual provision HSE penalties shall be imposed on subcontractors for non- compliance on HSE requirement as per format no. HSEP:14-F14. The list in the format is only indicative. For any other violation, not listed in the format, the minimum penalty amount is to be decided as per BOCW act.
- If principal customer/statutory and regulatory bodies impose some penalty on HSE due to the non-compliance of the subcontractor the same shall be passed on to them.
- The penalty amount shall be recovered by Site Finance department from subcontractors from the RA/Final bill.

15.0 OTHER REQUIREMENTS

- In case of any delay in completion of a job due to mishaps attributable to lapses by the subcontractor, BHEL shall have the right to recover cost of such delay from the payments due to the subcontractor, after notifying the subcontractor suitably.
- If the subcontractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the subcontractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instruction regarding safety issued by BHEL, BHEL shall have the right to take corrective steps at the risk and cost of the subcontractor after giving a notice of not less than 7 days indicating the steps that would be taken by BHEL.
- If the subcontractor succeeds in carrying out its job in time without any fatal or disabling injury incident and without any damage to property BHEL may, at its sole discretion, favorably consider to reward the subcontractor suitably for the performance.
- In case of any damage to property due to lapses by the subcontractor, BHEL shall have the right to recover the cost of such damages from the subcontractor after holding an appropriate enquiry.
- The subcontractor shall take all measures at the sites of the work to protect all persons from incidents and shall be bound to bear the expenses of defense of every suit, action or other proceeding of law that may be brought by any persons for injury sustained or death owing to neglect of the above precautions and to pay any such persons such compensation or which may with the consent of the subcontractor be paid to compromise any claim by any such person, should such claim proceeding be filed against BHEL, the subcontractor hereby agrees to indemnify BHEL against the same.
- The subcontractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead in any form. Wherever men above the age of 18 are employed on the work of lead painting, overalls shall be supplied by the subcontractor to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.
- The subcontractor shall notify BHEL of his intention to bring to site any equipment or material which may create hazard.
- BHEL shall have the right to prescribe the conditions under which such equipment or materials may be handled and the subcontractor shall adhere to such instructions.

- BHEL may prohibit the use of any construction machinery, which according to the organization is unsafe. No claim for compensation due to such prohibition will be entertained by BHEL.

16. NON COMPLIANCE

NONCONFORMITY OF SAFETY RULES AND SAFETY APPLIANCES WILL BE VIEWED SERIOUSLY AND BHEL HAS RIGHT TO IMPOSE FINES ON THE SUBCONTRACTOR AS UNDER FOR EVERY INSTANCE OF VIOLATION NOTICED:

SN	Violation of Safety Norms	Fine (in Rs)
01	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03	Not wearing safety shoe	200/-*
04	Not keeping gas cylinders vertically	200/-
05	Not using flash back arrestors	100/-
06	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slinging properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

- Legend:-

  *: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

  #: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

Any other non-conformity noticed not listed above will also be fined as deemed fit by BHEL. The decision of BHEL engineer is final on the above. The amount will be deducted from running bills of the subcontractor. The amount collected above will be utilized for giving award to the employees who could avoid incident by following safety rules. Also the amount will be spent for purchasing the safety appliances and supporting the safety activity at site.

17.0 HSE AUDIT/INSPECTION

- Regular HSE Audit/inspection shall be carried out by Subcontractor as per Site HSE audit calendar.
- HSE checklist **(Annexure 02)** shall be used for carrying out audit/inspection and report shall be submitted to BHEL site management
- All non-conformities and observations on HSE identified during internal or external HSE audit shall be disposed off by site in a time bound manner and reported back the implementation status
- Corrective action and Preventive action on HSE issues raised by certification body issued by Regional HQs shall be implemented by site and reported to Site management.

18.0 MONTHLY HSE REVIEW MEETING

- Site shall hold HSE review meeting every month to discuss and resolve HSE issues of site and improve HSE performance. It will also discuss the incidents occurred since previous meeting,its root cause and Corrective action and Preventive action. The agenda is given below:
  - Implementation of earlier MOM
  - HSE performance
  - HSE inspection
  - HSE audit and CAPA
  - HSE training
  - Health check-up camp
  - HSE planning for the erection and commissioning and installation activities in the coming month
  - HSE reward and promotional activities
- The meeting shall be chaired by Construction Manager, convened by HSE coordinator and attended by all HOS, Site Incharge of Subcontractors and HSE officer of Subcontractors.
- MOM on the discussion will be circulated to the concerned for implementation.

19.0 FORMATS USED (Details available in Annexure-04)

SL. No.	Format Name	Format No.	Rev No.
01	Inspection of First Aid Box	HSEP:14-F01	00
02	Health Check Up	HSEP:14-F02	00
03	HSE Induction Training	HSEP:14-F03	00
04	Tool Box Talk	HSEP:14-F04	00
05	Monthly Site HSE Report	As specified by BHEL	00
06	Inspection of PPE	HSEP:14-F06	00

07	Inspection of T&Ps	HSEP:14-F07	00
08	Status of T&Ps	HSEP:14-F08	00
09	Inspection of Cranes and Winches	HSEP:14-F09	00
10	Inspection on Height Working	HSEP:14-F10	00
11	Inspection on Welding & Gas Cutting	HSEP:14-F11	00
12	Inspection on Electrical Installation	HSEP:14-F12	00
13	Inspection on Elevator	HSEP:14-F13	00
14	HSE Penalty	HSEP:14-F14	00
15	Accident /incident / property damage /fire incident report	HSEP:14-F15	00

20.0 ANNEXURES

ANNEXURE 01

As per Contract Labour (Regulation & Abolition Act), Central Rules, 1971,

(1) The first-aid box shall be distinctively marked with a Red Cross on a white background and shall contain the following items, namely:

(a) For establishments in which the number of contract labour employed does not exceed fifty, each first aid box shall contain the following equipment:

(i)	6 small sterilized dressings
(ii)	3 medium size sterilized dressings
(iii)	3 large size sterilized dressings
(iv)	6 pieces of sterilized eye pads in separate sealed packets.
(v)	6 roller bandages 10 cm wide.
(vi)	6 roller bandages 5 cm wide.
(vii)	One tourniquet
(viii)	A supply of suitable splints
(ix)	Three packets of safety pins.
(x)	Kidney tray.
(xi)	3 large sterilized burn dressings.
(xii)	1 (30ml) bottle containing a two percent alcoholic solution of iodine
(xiii)	1 (30 ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label
(xiv)	1 snake bite lancet
(xv)	1 (30gms) bottle of potassium permanganate crystals.
(xvi)	1 pair scissors
(xvii)	1 copy of the First-Aid leaflet issued by the Director General, Factory Advice Service and Labour Institutes, Government of India.
(xviii)	A bottle containing 100 tablets (each of 5 grains) of aspirin
(xix)	Ointment for burns
(xx)	A bottle of suitable surgical anti-septic solution

(b) For establishment in which the number of contract labour exceeds fifty each first-aid box shall contain the following equipment:

(i)	12 small sterilized dressings
(ii)	6 medium size sterilized dressings
(iii)	6 large size sterilized dressings.
(iv)	6 large size sterilized burn dressings
(v)	6 (15 grams) packets sterilized cotton wool
(vi)	12 pieces of sterilized eye pads in separate sealed packets.

(vii)	12 roller bandages 10 cm wide.
(viii)	12 roller bandages 5 cm wide.
(ix)	One tourniquet.
(x)	A supply of suitable splints.
(xi)	Three packets of safety pins.
(xii)	Kidney tray.
(xiii)	Sufficient number of eye washes bottles filled with distilled water or suitable liquid clearly indicated by a distinctive sign which shall be visible at all times.
(xiv)	4 per cent Xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops.
(xv)	1 (60ml) bottle containing a two percent alcoholic solution of iodine
(xvi)	One (two hundred ml) bottle of mercurochrome (2 per cent) solution in water.
(xvii)	1 (120ml) bottle containing Sal volatile having the dose and mode of administration indicated on the label.
(xviii)	1 roll of adhesive plaster (6 cmX1 meter)
(xix)	2 rolls of adhesive plaster (2 cmX1 meter)
(xx)	A snake bite lancet.
(xxi)	1 (30 grams) bottle of potassium permanganate crystals.
(xxii)	1 pair scissors
(xxiii)	1 copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India.
(xxiv)	a bottle containing 100 tablets (each of 5 grains) of aspirin
(xxv)	Ointment for burns
(xxvi)	A bottle of a suitable surgical anti septic solution.

(2) Adequate arrangement shall be made for immediate recoupment of the equipment when necessary.

ANNEXURE 02

HSE AUDIT/INSPECTION CHECKLIST CUM COMPLIANCE REPORT

PROJECT:_____ SUBCONTRACTOR:_____

DATE : _____ OWNER :_____

INSPECTION BY:_____

Note : write 'NA' wherever the items is not applicable

Item	Yes	No	Remarks	Action
HOUSEKEEPING				
Waste containers provided and used				
Passageways and walkways clear				
General neatness of working area				
Other				
PERSONNELPROTECTIVEEQUIPTMENTS				
Goggles; shields				
Face protection				
Hearing protection				
Respiratory masks etc.				
Safety belts				
Other				
EXCAVATIONS / OPENINGS				
Openings properly covered or barricaded				
Excavations shored				
Excavations barricaded				
Overnight lighting provided				
Other				
WELDING, CUTTING				
Gas cylinders chained upright				
Cable and hoses not obstructing				
Fire extinguisher (s) accessible				
Others				
SCAFFOLDING				
Fully decked platforms				
Guard and intermediate rails in place				
Toe boards in place				
Adequate shoring				
Adequate access				
Others				
LADDER				
Extension side rails 1 m above				
Top of landing				
Properly secured				

Angle + 70^0 from horizontal				
Other				
HOISTS, CRANES AND DERRICKS				
Condition of cables and sheaf OK				
Condition of slings, chains, hooks OK				
Inspection & maintenance log maintained				
Outriggers used				
Signals observed and understood				
Qualified operators				
Others				
MACHINERY, TOOLS & EQUIPMENT				
Proper instruction				
Safety devices				
Proper cords				
Inspection and maintenance				
Other				
VEHICLE AND TRAFFIC				
Rules and regulations observed				
Inspection and maintenance				
Licensed drivers				
Other				
TEMPORARY FACILITIES				
Emergency instructions posted				
Fire extinguishers provided				
Fire-aid equipment available				
General neatness				
Others				
FIRE PREVENTION				
Personnel instructed				
Fire extinguishers checked				
No smoking in prohibited areas.				
Hydrants				
Clearance				
Others				
ELECTRICAL				
Proper wiring				
ELCB's provided				
Ground fault circuit interrupters				
Protection against damage				
Prevention of tripping hazards				
Other				
HANDLING & STORAGE OF MATERIALS				
Properly stored or stacked				
Passageways clear				
Other				
FLAMMABLE GASES AND LIQUIDS				
Containers clearly identified				
Proper storage				
Fire extinguisher nearby				

Other				
WORKING AT HEIGHT				
Safety nets				
Safety belts				
Safety helmets				
Anchoring of safety belt to the life line rope				
ENVIRONMENT				
Lubricant waste/engine oils properly dispose.				
Waste from Canteen, offices, sanitation etc. disposed properly.				
Disposal of surplus earth, stripping materials, expired batteries, oily rags and combustible materials done properly.				
HEALTH CHECKS				
Hygienic conditions at labor camps O.K.				
Availability of first-aid facilities				
Proper sanitation at site, office & labor camps.				
Arrangement of medical facilities.				
Measures for dealing with illness.				
Availability of potable drinking water for workmen & staff.				
Provision of crèches for children.				

ANNEXURE 03

REFERENCES

- Contract documents
- Relevant legislations
- HSEMSM
- Relevant Indian standards as listed below (illustrative only):

SL NO	CODE NAME	TITLE
(1)	IS : 818-1888 (Reaffirmed 2003)	Code of Practice for safety and health requirements in Electric and Gas Welding and Cutting operations.
(2)	IS: 1179-1967 (Reaffirmed 2003)	Specification for Equipment for Eye & Face protection during welding.
(3)	IS : 1989 (Part 2):1986 (Reaffirmed 1997)	Specification for Leather Safety Boots & Shoes
(4)	IS:2925 – 1984 (Reaffirmed 2010)	Specification for Industrial Safety Helmets
(5)	IS:3521 : 1999 (Reaffirmed 2002)	Industrial Safety Belts & Harnesses-Specification
(6)	IS:3646(Part II) – 1966 (Reaffirmed 2003)	Code of Practice for Interior Illumination
(7)	IS:3696 (Part I) – 1987 (Reaffirmed 2002)	Safety Code for Scaffolds and Ladders
(8)	IS: 3696(Part 2) : 1991 (Reaffirmed 2002)	Scaffolds and Ladders-Code of Safety
(9)	IS:3786 – 1983 (Reaffirmed 2002)	Method for Computation of Frequency and Severity Rates for Industrial Injuries and Classification of Industrial Incidents
(10)	IS:4770 : 1991 (Reaffirmed 2006)	Rubber Gloves – Electricals purposes-Specification
(11)	IS:4912 : 1978 (Reaffirmed 2002)	Safety Requirements for Floor and Wall Openings, Railings and Toe Boards
(12)	IS: 5983 – 1980 (Reaffirmed 2002)	Specification for Eye-Protectors
(13)	IS:6519 – 1971 (Reaffirmed 1997)	Code of Practice for Selection, Care and Repair of Safety Footwear
(14)	IS:9167:1979	Specification for Ear-Protectors
(15)	IS:6994(Part I)-1973 (Re affirmed 1996)	Specification for Industrial Safety Gloves Leather and Cotton Gloves
(16)	IS:8519 – 1977 (Reaffirmed 1983)	Guide for Selection of Industrial Safety Equipment for Body Protection.
(17)	IS 11006 : 2011	Flash Back(Flame Arrestor) Specification

(18)	IS:8520 – 1977 (Reaffirmed 2002)	Guide for Selection of Industrial Safety Equipment for Eye, Face and Ear Protection.
(19)	IS:9473:2002	Respiratory Protective Devices-Filtering Half Masks to protect against Particles-Specification.
(20)	IS:9944:1992 (Reaffirmed 2003)	Natural and Man-made Fiber Rope Slings-Recommendations on Safe working loads.
(21)	IS:11057 – 1884 (Reaffirmed 2001)	Specification for Industrial Safety Nets
(22)	IS:12254:1993 (Reaffirmed 2002)	Polyvinyl Chloride (PVC) Industrial Boots-Specification
(23)	IS:13367(Part 1):1992 (Reaffirmed 20030	Safe Use of Cranes-Code of Practice
(24)	IS:14166:1994 (Reaffirmed 2002)	Respiratory Protective Devices-Full Face Masks Specification
(25)	IS:14746 : 1999 (Reaffirmed 2003)	Respiratory Protective Devices-Half Masks and Quarter Masks - Specification
(26)	IS : 15397 :2003 (Reaffirmed 2008)	Portable Extinguisher Mechanical Foam Type(Stored Pressure)-Specification
(27)	IS: 19011:2002	Guidelines for Quality and/or Environmental Management Systems Auditing

ANNEXURE 04 : SAFETY FORMATS
&
ANNEXURE 05 : WORK PERMIT FORMATS

	POWER SECTOR	FORMAT NO: HSEP:14-F01 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF FIRST AID BOX	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Number of employees on the site: -_____

Sl.No.	**Item**	**No. Available**	**Remarks**
1	No. of small sterilized dressings		
2	No of medium sized sterilized dressings		
3	No of large sized sterilized dressings.		
4	No of large sized sterilized burn dressings		
5	No of (15 grams) packets sterilized cotton wool		
6	No of pieces of sterilized eye pads in separate sealed packets.		
7	No of roller bandages 10 cm wide.		
8	No of roller bandages 5 cm wide.		
9	Whether tourniquet available		
10	Whether supply of Suitable splints available.		
11	No of packets of safety pins.		
12	Whether kidney tray available		
13	Whether sufficient number of eye wash bottles, filled with distilled water or suitable liquid, clearly indicated by a distinctive sign which shall be visible at all times, available.		
14	Whether 4%-xylocaine eye drops, and boric acid eye drops and soda by carbonate eye drops available.		
15	Whether (60ml) bottle containing a two percent alcoholic solution of iodine available		
16	Whether (two hundred ml) bottle of mercurochrome (2 per cent) solution in water available.		

Sl.No.	Item	No. Available	Remarks
17	Whether 120ml bottle containing Sal volatile having the dose and mode of administration indicated on the label, available.		
18	Whether roll of adhesive plaster (6 cmX1 meter) available		
19	No of rolls of adhesive plaster (2 cmX1 meter)		
20	Whether snake bite lancet available.		
21	Whether (30 grams) bottle of potassium permanganate crystals available.		
22	Whether a pair scissors available		
23	Whether copy of the First-Aid leaflet issued by the Director-General, Factory Advice service and labour Institutes, Government of India available.		
24	Whether bottle containing 100 tablets (each of 5 grains) of aspirin available		
25	Whether Ointment for burns available		
26	Whether bottle of a suitable surgical anti-septic solution available		

Signature of Subcontractor's Site I/C:

	POWER SECTOR	FORMAT NO: HSEP:14-F02 REV NO.: 00 PAGE NO. 1 OF 02
	HEALTH CHECK UP	

Name of Site :	
Name of Sub-Contractor :	
Name of Employee :	

NAME:

History Of Past Illness	H/O Epilepsy
	H/O Drug Allergy
	H/O Diabetics/ Hypertension
	H/O Unconsciousness
Personal History	

EXAMINATION		**OBSERVATION**	
General Physical Examination			
Height	:		
Weight	:		
BMI	:		
Built And nourishment	:		
Pallor	:		
Temperature	:		
Chest Expansion	:	Inspiration	Expansion
Lymph Node Enlargement	:		
Ear, Nose, Throat	:		
Ear	:		
Nose	:		
Throat	:		

EXAMINATION		OBSERVATION	
Cardiovascular System Examination :			
Inspection	:		
Palpation	:	Pulse	BP
Auscultation (Heart Sounds)	:		
Respiratory System	:		
Inspection	:	Respiratory Rate	
Palpation:	:		
Percussion	:		
Auscultation (Breath Sounds)	:		
Examination of Abdomen	:		
Inspection	:		
Palpation	:		
Auscultation (Bowel Sounds)	:		
Any Other	:		
Clinical Impression			

Signature of the examining doctor

	POWER SECTOR **HSE INDUCTION TRAINING**	FORMAT NO: HSEP:14-F03 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Date :	
Name of Training Co-ordinator	

Sl No.	**Name**	**Designation**	**Organisation**	**Signature**

Signature of Training co-ordinator :

	POWER SECTOR	FORMAT NO: HSEP:14-F04 REV NO.: 00 PAGE NO. 01 OF 01
	TOOL-BOX TALK	

Name of Site :	
Sub-Contractors Name :	
Date :	

Topic	**Name of person delivered Tool Box Talk**	**No. of Participants attended**	**Remarks**

Signature of Site I/C of Subcontractor :

	POWER SECTOR **PERSONAL PROTECTIVE EQUIPMENTS**	FORMAT NO: HSEP:14-F06 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Item	**Issued this Month**	**Nos. Issued up to the Month**	**Percentage of usage at site**
Safety Helmet			
Safety Shoes			
Full Body Harness			
Fall Arrestor			
Safety Nets			
Other PPEs.			

Signature of Site I/C of Subcontractor :

	POWER SECTOR **INSPECTION OF T&Ps**	FORMAT NO: HSEP:14-F07 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Date of Inspection :	

Sl.No.	Description	Remarks	
1.0	Name of equipment		
2.0	Basic Information of equipment		
2.1	Specification		
2.2	Sr. No. of equipment		
2.3	Make		
2.4	Year of manufacture		
3.0	Major repairs / overhauls(Furnish details of work carried out)		Date(s) of major repair/overhaul
3.1			
3.2			
3.3	Repairs carried out at site		
4.0	Any performance test conducted	Yes/No	
5.0	Document Submitted	Yes/No	
6.0	Manufacturer's test / guarantee certificate	Available/ Not available	
7.0	Performance test	Done/ Not Done	
8.0	Acceptance Norms		
9.0	Committee Observations		
10.0	Date of next review (if accepted)		

Signature-Site Safety Officer (BHEL)	**Signature-Subcontractor/ Subcontractor's Safety Officer**

	POWER SECTOR **STATUS OF T&Ps**	FORMAT NO: HSEP:14-F08 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site	
Name of Sub-Contractor	
Date of Inspection	

Item	**Nos. Deployed**	**Identification No.**	**Nos. Tested by competent person**	**Validity of Test Certificate**
Winches				
Chain Blocks				
Wire Rope Slings				
Man Cages				
D-Shackles				
Air Compressors				
Crawler Cranes				
Mobile Cranes				
Hydra Cranes				
Others				

Signature of Site I/C of subcontractor:

	POWER SECTOR **INSPECTION OF CRANES AND WINCHES**	FORMAT NO: HSEP:14-F09 REV NO.: 00 PAGE NO. 01 OF 03

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Crane Reg. No (Make/Model) _____

Name of Driver/Operator _____

Sl.no.	Description	Observation	Measures
1	Valid Driving license		
2	Hook & Hook Latch		
3	Over Hoist limit switch		
4	Boom limit switch		
5	Boom Angle Indicator		
6	Boom limit cutoff switch		
7	Condition of Boom		
8	Condition of ropes		
9	Number of load lines		
10	Size and condition of the slings		
11	Stability of the cranes		
12	Soil Condition		
13	Swing Break And Lock		
14	Proper Break And Lock		
15	Hoist Break And Lock		
16	Boom Break And Lock		
17	Main Clutch		
18	Leakage in Hydraulic Cylinders		
19	Out riggers filly extendable		
20	Tyre pressure		
21	Condition of Battery And Lamps		

Sl.no.	Description	Observation	Measures
22	Guards of moving and rotating parts		
23	Load chart provided		
24	Number and position of pedant ropes		
25	Reverse Horn		
26	Load Test Details		
27	Operator's fitness		
28	Pollution under control certificate		
29	Fire extinguisher of appropriate type.		
30	Training of the operator		

WINCH

Sl. No.	Description	YES	NO	NA	Remarks
1	Has the copy of Third Party Inspection certificate been provided in winch machine shed?				
2	Is winch machine operator experienced enough to operate the winch machine?				
3	Is the winch machine operated by someone other than the winch machine operator?				
4	Is there guard provided in all moving parts like wheel and motor's shaft?				
5	Will it protect against unforeseen operational contingencies?				
6	Are brakes, clutch and locking arrangement working properly?				
7	Has it been ensured that the guard does not constitute a hazard by itself?				
8	Are the cranks and the connecting rods protected by guardrails?				
9	Is there provision for fully covered shed with wooden plank roof?				

Sl. No.	Description	YES	NO	NA	Remarks
10	Is wire rope free from any kind of damage or wear and tear?				
11	Is split pin provided for the protection of clutch and brake locking arrangement?				
12	Is pulley inspected by competent person and certified before use?				
13	Is pulley free from any wear and tear visually?				
14	Is winch rope barricaded with clipsheet for the protection of rope and person?				
15	Is the wire rope lubricated by cardium oil?				
16	Is there any friction in wire rope which may damage the wire rope rather than the rolling parts?				
17	Is there any oil leakage in the hydraulic system of the winch machine?				
18	Has it been ensured that the guard will not cause discomfort or inconvenience to operator?				
	Total Number of NO:				
	Total Number of NA:				
	% Compliance :				

Signature of Site I/C of subcontractor :

	POWER SECTOR	FORMAT NO: HSEP:14-F10 REV NO.: 00 PAGE NO. 01 OF 02
	INSPECTION OF HEIGHT WORKING	

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection:	

Sl. No.	**Descriptions**	**Observation (Yes/No)**	**Remarks**
1	All the workers have been explained safe work method?		
2	An established communication system has been established and explained to the workers.		
3	Adequate illumination has been ensured.		
4	Work area inspected prior to the start of the work.		
5	Area below the work place barricaded, particularly below hot work.		
6	Workers provided with bags /box to carry bolts, nuts and hand tools		
7	Arrangement for fastening hand tools made.		
8	All work platforms ensured to be of adequate strength and ergonomically suitable.		
9	Fabricated makeshift arrangements are checked for quality and type of material welding, anchoring etc.		
10.	Work at more than one elevation at the same segment is restricted.		
	ACCESS/EGRESS		
1	Walkways provided with handrail, mid-rail and toe guard?		
2	All checkered plates, gratings properly welded/ bolted?		
3	Are ladders inspected and they are in good condition?		
4	Are ladders spliced?		
5	Are ladders properly secured to prevent slipping, sliding or falling?		
6	Do side rails extend 36” above top landing?		
7	Are built up ladders constructed of sound materials?		

Sl. No.	Descriptions	Observation (Yes/No)	Remarks
8	Are rugs and cleats not over 12” on center?		
9	Metal ladders not used around electrical hazards.		
10	Proper maintenance and storage.		
11	Ladders placed at right slope.		
12	Ladders / staircases welded/ bolted properly.		
13	Any obstruction in the stairs.		
14	Are landing provided with handrails, knee rails, toe boards etc.?		
15	Whether ramp is provided with proper slope.		
16	Proper hand rails / guards provided in ramps.		
	Housekeeping		
1	Walkways, aisles & all overhead workplaces cleared of loose material.		
2	Flammable materials, if any, are cleared.		
3	All the de shuttering materials are removed after de shuttering is done.		
4	Platforms and walkways free from oil/grease or other slippery material.		
5	Collected scrap are brought down or lowered down and not dropped from height.		
	PPE And Safety Devices		
1	Use of safety helmet, safety belts ensured for all workers		
2	Anchoring points provided at all places of work.		
3	Common lifeline provided wherever linear movement at height is required.		
4	Safety nets are use wherever required.		
5	Proper fall arrest system is deployed at critical workplaces.		
6	Crawler boards/Safety system or works on fragile roof are used.		

Signature of Site I/C of subcontractor :

	POWER SECTOR **INSPECTION OF WELDING AND GAS CUTTING**	FORMAT NO: HSEP:14-F11 REV NO.: 00 PAGE NO. 1 OF 02

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Welding				
Sl.no.	Description	Yes	No	Remarks
1	Is electric connection given through 30 mA ELCB/RCCB to welding m/c?			
2	Is electric cable fitted properly in junction box on m/c?			
3	Is electrical cable free from joints?			
4	Are the joints attached firmly & insulated with tape?			
5	Is double earthing given to body of m/c?			
6	Is the physical condition of the m/c good?			
7	Is ON/OFF switch connected to the m/c is working and in good condition?			
8	Are indication lamps on m/c working?			
9	Is the electrode holder in good condition?			
10	Are the cables of the welding m/c lugged & tight properly?			
11	Are return lead connected properly (Rod, Angle, Channels shall not be used)			
	Total No of NO			
	Total No of YES			

	POWER SECTOR **INSPECTION OF WELDING AND GAS CUTTING**	FORMAT NO: HSEP:14-F11 REV NO.: 00 PAGE NO. 2 OF 02

Gas Cutting				
Sl. no	Description	Yes	No	Remarks
1	Are Cylinders kept on trolleys?			
2	Physical condition of Gas cylinders Good?			
3	Is there Oil/Grease on valve of the cylinder?			
4	Are pressure regulators in good condition?			
5	Condition of hose pipe OK?			
6	Are hose pipe clamped with hose clip?			
7	Is flash back arrestor & NRV fitted on torch both for O2 and LPG cylinder?			
8	Is nozzle of the torch cleaned?			
	Total Number of NO			
	Total No of YES			
	% Compliance			

Signature of Site I/C of subcontractor :

	POWER SECTOR **INSPECTION OF ELECTRICAL INSTALLATION**	FORMAT NO: HSEP:14-F12 REV NO.: 00 PAGE NO. 01 OF 02

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection:	

Sr. No.	**Contents**	**Yes/No**	**Remarks**
A	**Cable**		
1.	Whether the condition of cable is checked?		
2.	Are cables received from other sites checked for insulation resistance before putting them into use?		
3.	Are all main cables taken either underground / overhead?		
4.	Are welding cables routed properly above the ground?		
5.	Are welding and electrical cables overlapping?		
6.	Is any improper joining of cables/wires prevailing at site?		
B	**DBs/SDBs**		
1.	Is earth conductor continued up to DB / SDB?		
2.	Whether DBs and extension boards are protected from rain / water?		
3.	Is there any overloading of DBs / SDBs?		
4.	Are correct / proper fuses & CBs provided at main boards and sub-boards?		
5.	Is energized wiring in junction boxes, CB panels & similar places covered all times?		
C	**ELCB**		
1.	Whether the connections are routed through ELCB?		
2.	Is ELCB sensitivity maintained at 30 mA?		

Sr. No.	Contents	Yes/No	Remarks
3.	Are the ELCB numbered and tested periodically & test results recorded in a logbook countersigned by a competent person?		
D	**Grounding**		
1.	Is natural earthing ensured at the source of power (main DB at Generator or Transformer)?		
2.	Whether the continuity and tightness of the earth conductor are checked?		
3.	Mention the gauge of the earth conductor used at the site.		
4.	Mention the value of Earth Resistance.		
E	**Electrically operated Machines or Accessories**.		
1.	Whether the plug top is provided everywhere.		
2.	Are all metal parts of electrical equipment and light fittings / accessories grounded?		
3.	Is there any shed or cover for welding machines?		
4.	Are halogen lamps fixed at proper places?		
5.	Are portable power tools maintained as per norms?		
6.	Any other information:		

Signature of Site I/C of subcontractor :

	POWER SECTOR **INSPECTION OF ELEVATOR**	FORMAT NO: HSEP:14-F13 REV NO.: 00 PAGE NO. 01 OF 01

Name of Site	
Name of Sub-Contractor	
Inspected by	
Date of Inspection	

Sr. No.	**Description**	**Remarks**	
1.0	Name of equipment		
2.0	Basic Information of equipment		
2.1	Specification		
2.2	Sr. No. of equipment		
2.3	Make		
2.4	Year of manufacture		
3.0	Major repairs/overhauls(Furnish details of work carried out)		Date(s) of major repair/overhaul
3.1			
3.2			
3.3	Repairs carried out at site		
4.0	Any performance test conducted	Yes/No	
5.0	Document Submitted	Yes/No	
6.0	Manufacturer's test / guarantee certificate	Available/ Not available	
7.0	Performance test	Done/ Not Done	
8.0	Acceptance Norms		
9.0	Committee Observations		
10.0	Date of next review (if accepted)		

Signature-Subcontractor/ Subcontractor's Safety Officer	**Signature-Site Safety Officer (BHEL)**

	POWER SECTOR **Inspection of Excavation**	FORMAT NO: **HSEP:14-F13E** REV NO.: 00 PAGE NO. 01 OF 01

Name of Site :	
Name of Sub-Contractor :	
Inspected by :	
Date of Inspection :	

Sl.no.	Description	Yes	No	Remarks
1	Precautions taken for Underground Electrical Cable			
2	Precautions taken for Under / Above ground sewer/ Drinking Water Line			
3	Precautions taken for Underground Telecommunication Line			
4	Precautions taken for Underground Product/Utility Line			
5	Precautions taken for Underground Fire Water Line			
6	Shoring / Shuttering / Sheet piling done to prevent collapse of excavation walls. Strength of Excavation wall ensured at all times			
7	Slope Cutting / Angle Maintained			
8	Hard Barricading & Edge Protection provided			
9	Separate Safe Access for Man and Vehicle			
10	Lighting arrangement			
11	Banksman Provided			
12	Required basic PPEs provided			
13	Excavated soil / Construction Material / equipment kept away from the edge.			
14	First aid in attendance.			
15	Other:			
	Total No of YES			

Signature-Subcontractor/ Subcontractor's Safety Officer **Signature-Site Safety Officer (BHEL)**

Sub: MEMO for Penalty for non-compliances in Safety

Following lapse (tick marked) was observed and penalty is imposed as stated at the bottom of this memo. It is requested that such occurrences be please avoided in future.

Safety Area

SN	Violation of Safety Norms	Fine (in Rs)
01	Not Wearing Safety Helmet	200/- *
02.	Not wearing Safety Belt or not anchoring life line	500/-*
03	Not wearing safety shoe	200/-*
04	Not keeping gas cylinders vertically	200/-
05	Not using flash back arrestors	100/-
06	Not wearing gloves	50/- *
07.	Grinding Without Goggles	50/- *
08.	Not using 24 V Supply For Internal Work	500/-
09.	Electrical Plugs Not used for hand Machine	100/-
10.	Not Slinging properly	200/-
11.	Using Damaged Sling	200/-
12.	Lifting Cylinders Without Cage	500/-
13.	Not Using Proper Welding Cable With Lot of Joints And Not Insulated Property.	200/-
14.	Not Removing Small Scrap From Platforms	500/-
15.	Gas Cutting Without Taking Proper Precaution or Not Using Sheet Below Gas Cutting	500/-
16.	Not Maintaining Electric Winches Which are Operated Dangerously	500/-
17.	Improper Earthing Of Electrical T&P	500/-
18	No or improper barricading	500/-
19.	Activity carried out without Safety work permit (Height work, Lifting activity, Hot work-each person/case)	1000/-
20.	Incident Resulting in Partial Loss in Earning Capacity	25,000/- per victim
21.	Fatal Incident Resulting in total loss in Earning Capacity	1,00,000/- per victim for first instance #

Legend: -

*: per head. For repeated violation by the same person, the penalty would be double of the previous penalty. Date of "Repeated violation" will be counted from subsequent days.

#: or as deducted by customer, whichever is higher. For repeated fatal incident in the same Unit incremental penalty to be imposed. The subcontractor will pay 2 times the penalty compared to previously paid in case there are repeated cases of fatal incidents under the same subcontractor for the same package in the same unit.

Details (if any) related to non- compliance (Name of persons, Nature of deficiency, etc.)

_____

Penalty imposed:

1, Rate as per above chart_____

2. No. of Persons/ machine/ event/ labour _____

3. Total Penalty= 1. X 2. =_____

Signature:

Witnessed by: (Sub- Contractor representative) (BHEL Personnel)

Name_____ Name_____

Distribution: 1 Copy: to Sub- contractor,
1 Copy to Site Construction Manager (BHEL)

बी एच ई एल BHEL	**POWER SECTOR- HQ** **Incident Report** (To be submitted within 24 hours of time of incident)	FORMAT NO: HSEP:14-F15 REV NO.: 00 PAGE NO. 01 OF 01

Type of incident: Fatal/Major/ Minor/Fire/Property Damage/Near-miss

1	NAME OF SITE		3	ACTIVITY AREA	
2	SCOPE OF WORK		4	NAME OF CONTRACTOR	
			5	NAME & DESIGNATION OF BHEL ACTIVITY I/C	
6	DATE & TIME OF ACCIDENT		7	DATE RESUMED	
8	NO. OF WORK-DAYS LOST BY VICTIM (If duty not resumed, give estimated figure)				
9	NO. OF MANHOURS LOST BY OTHERS				
10	PERSONAL DETAILS OF INJURED AND / OR DETAILS OF MATERIALS / EQUIPMENT / PROPERTY DAMAGED				

NAME				NAME OF MATERIAL / EQUIPMENT / PROPERTY	
PERIOD OF EMPLOYMENT					
AGE	YRS	SEX	MALE/ FEMALE	ESTIMATED COST	ACTUAL COST
MARITAL STATUS		SINGLE / MARRIED			
OCCUPATION				NATURE OF DAMAGE	
PART OF BODY INJURED					
NATURE OF INJURY					
AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) MOST RESPONSIBLE FOR CAUSING ACCIDENT / INJURY / DAMAGE					
12	PERSON (NAME & DESIGNATION) WITH MOST CONTROL OVER AGENCY (OBJECT / EQUIPMENT / SUBSTANCE) CAUSING ACCIDENT INJURY / DAMAGE				
13	DESCRIBE CLEARLY HOW THE ACCIDENT OCCURRED (USE ADDITIONAL SHEET, IF REQUIRED				
ANALYSIS					
14	WHAT ACTS AND / OR CONDITIONS CONTRIBUTED MOST DIRECTLY TO THIS ACCIDENT				
15	WHAT ARE THE BASIC REASON FOR THE EXISTENCE OF THESE ACTS AND / OR CONDITION ?				
16	WHAT CORRECTIVE ACTIONS HAVE BEEN TAKEN TO PREVENT ACCIDENT RECURRENCE ?				
	DATE :			SIGNATURE OF SITE HSE COORDINATOR	
17	COMMENTS OF HEAD / SOX				
	DATE:			SIGNATURE OF HEAD/SOX	

	POWER SECTOR **Format for Monthly HSE Planning & Review**	FORMAT NO: **HSEP:14-F30** REV NO.: 00 PAGE NO. 01 OF 3

Note: This is a template and can be modified in consultation with BHEL			
Name of the Site		**Name of the Subcontractor**	
Scope of Work		**Date**	
PART- A: PLAN OF HSE ACTIVITIES FOR THE MONTH OF……			**PART-B: REVIEW ON ……**
SN.	**Description of HSE Activity & Formats**	**Plan & Targets for the month**	**Review**
1	Availability of First Aid Box at Required Places and Inspection thereof as per Format: F01	Areas 1. … …	
2	Health check-up as per Format: F02	Health check-up for Nos 1. New inductees 2. Drivers & Operators 3. Workers in following high risk areas: a. …	
3	Induction training of newly joined workers as per Format: F03	Minimum No. of workers:	
4	Toolbox talks (TBT) conducted before start of work as per Format: F04	Locations of TBTs & No. of workers **1.** …	
5	PPE usage and issue as per Format: F06		
6	Inspection of T&Ps as per Format: F07	List of T&Ps to be inspected 1.	
7	Identification & Inspection Status of T&Ps as per Format: F08		
8	Inspection of Cranes & Winches as per Format: F09	List of Cranes & Winches & Nos. 1. …	
9	Inspection of Height Working as per Format: F10	Areas: 1. …	
10	Inspection of Welding & Gas Cutting operations as per Format: F11	Areas: 1. …	
11	Inspection of Electrical Installations as per Format: F12	Locations: 1. …	
12	Inspection of Elevators (as applicable) as per Format: F13	Locations: 1. …	
13	Inspection of Excavation as per Format: F13E	**Locations:** **1. …**	

SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
14	Job Safety Analysis as per Format F32B	**Activities:** **1. …**	
15	Regular Job Specific Training (Re-training) for workers involved in hazardous activities	Topics/ Hazards & No. of workers **1.** …	
16	Mass housekeeping (HK) drive in work areas	Areas **1.** …	
17	Vertigo Test of Height workers	Minimum No. of workers:	
18	Deployment of qualified HSE Officers as per contract	Location(s) & Nos. **1.** …	
19	Deployment of qualified HSE Stewards as per contract	Location(s) & Nos. **1.** …	
20	Deployment of Safety tools & Equipment (Safety Nets, Lifelines, Fall arrestors, Man-cages, flashback arrestors, scaffolding etc.)	Tool/ Equipment & Location **1.** …	
21	Safety Walks by site in charge of agency (4 -Weekly once)	Dates:	
22	Safety walks by departmental head (8-Weekly twice)	Dates:	
23	Availability/ deployment of Safety posters/ placards/ signage at strategic locations	Locations: Nos. **1.** …	
24	Provision of clean drinking water sources for workers	Locations: Nos. **1.** …	
25	Provision of toilets for workers (separate for male & female workers)	Locations: Nos. **1.** …	
26	Rest sheds for workers during lunchtime, rain, dust storm etc.	Locations: Nos. **1.** …	
27	Availability of following in Labor colony	**1. Clean drinking water** **2. Toilets** **3. Cleanliness & Hygiene** **4. Grass cutting,** **5. Fogging** **6. Electrical Inspection …**	

SN.	Description of HSE Activity & Formats	Plan & Targets for the month	Review
28	Availability of dust/ waste bins at various locations	Locations: **1.** …	
29	Availability of Ambulance (individual/ joint) in each shift	Ambulance No.	
30	Availability of emergency vehicle in each shift	Emergency vehicle	
31	Deployment/ Availability of tested Fire Extinguishers	Locations & Nos. **1.** …	
32	Tree plantation	Locations & Nos. **1.** …	
33	Waste disposal & Scrap Bins	Locations **1.** …	
34	Illumination checks	Locations **1.** …	
35	Safety award function: 1. Display of good practices Award presentation	Minimum 1 per month	
36	**Submission of Daily Reports as per Format No.F31A**	**Daily Reports (Night & Day Shifts)**	

PLAN		**REVIEW**	
Agency Name: Sign: Date:	**BHEL** Name: Sign: Date:	**Agency** Name: Sign: Date:	**BHEL** Name: Sign: Date:

	POWER SECTOR	FORMAT NO: **HSEP:14-F31** A REV NO.: 00 PAGE NO. 01 OF 1
	Format for Daily HSE Reporting	

Note: Following format to be submitted (preferably) in excel/ soft copy by subcontractor daily at the end of each shift. Any photographs/ records to be attached

Site									**Subcontractor**																		
Year							**Month**													**Day**							
SHIFT	Submitted By	Work Area(s)	Staff	Man-Power	Safety Officers	Safety Stewards	Tool Box (Topics and No. of Participants)	Induction Training (No. of Participants)	Vertigo Test (Numbers Tested)	On-the-Job Training (Topic & participants)	Work Permits	Job Safety Analyses conducted	Height Work Inspection	Other Hazardous Activities Inspection	T&P Inspection (Names & Nos. Inspected)	Safety Walk (Designation, Areas)	HSE Meeting	Safety Reward (Details)	Housekeeping/ Dust Suppression/ Tree Plantation Activities (Locations/Details)	Lost time Accident	Restricted Work Case	Medical Treatment Case	First Aid Case	Near miss	Property Damage/ Fire	Non-Compliances Submitted by BHEL	Complied by Agency	Any other Remarks/ Inputs
Day																											
Night															NA		NA	NA	NA								

	POWER SECTOR **Job Safety Analysis Format**	FORMAT NO: **HSEP:14-F32B** REV NO.: 00 PAGE NO. 01 OF 1

Name of the Site	
Name of the Subcontractor	
Activity, Area	

HAZARDS	**PRECAUTIONS**

(Name)	**Submitted By (Agency HSE)**		**Reviewed By (BHEL Execution)**		**Approved By (BHEL HSE)**	
(Sign)						
(Date)						

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
1a	Induction training for new workers conducted through audio-visual medium & documented ?	M	1	Induction Training Records
1b	Tool box talk conducted regularly as per plan, and documented?	M	1	Toolbox Talk Records
1c	Contractor in charge and safety in charge attended safety meetings?	M	2	Minutes of Meeting
1d	Whether observations in safety meetings are complied before next meeting?	M	2	-do-
1e	Preparation and submission of Monthly HSE report within stipulated time	M	1	Report submission date
1f	Preparation and submission of Incident/near-miss report and RCA Report (as applicable) within stipulated time	M	1	Incident/ Near Miss Records
1g	Carrying out Inspections and submission of Inspection reports within stipulated time	M	1	Inspection Records
1h	Regular Job Specific Training ensured for High Risk Workers (through audio-visual medium) as per plan	M	1	Training & Attendance Records
2a	Whether the contractor is registered under BOCW	M	2	BOCW Registration Certificate
2b	Availability of Qualified safety officer (1 for every 500 labour)	M	2	Safety Officer qualification & experience records
2c	Availability of Qualified safety supervisor (1 for every 100 labour)	M	2	Safety Officer qualification & experience records
2d	All the workers are provided and using safety helmets and safety shoes/gum boots	M	2	PPE Issue Records, Inspection/ non-conformity records
2e	Housekeeping done on regular basis and scrap removal at site	M	1	Housekeeping records, Inspection/ non-conformity records
2f	Usage of Goggles/Face shields and Hand gloves for gas cutter and grinders		1	PPE Issue Records, Inspection/ non-conformity records
2g	Wall openings & floor openings are guarded?		1	Inspection/ non-conformity records
2h	Adequate illumination provided in all working area?		1	Inspection/ non-conformity records
2i	Safety posters, sign boards and emergency contact numbers in all prominent location are displayed?		1	Inspection/ non-conformity records
2j	Availability of automatic reverse horns, Main horn, hook latches for Vehicles, mobile cranes, Hydras		1	Inspection/ non-conformity records
2k	Ban of carrying mobile phones to work place is implemented for workers		1	Inspection/ non-conformity records
2l	Availability of Tags & Inspection Certificates for Cranes of all capacities		1	Master T&P List with internal & external test details
2l.2	Availability of Tags & Inspection Certificates for Winches of all capacities		1	Master T&P List with internal & external test details
2l.3	Availability of Tags & Inspection Certificates, color coding for Chain pulley blocks		1	Master T&P List with internal & external test details
2l.4	Availability of Tags & Inspection Certificates for Vehicles - Trailers, Dozers, Dumpers, Excavators. Mixers etc.		1	Master T&P List with internal & external test details
2l.5	Availability of Tags & Inspection Certificates for Welding machines, grinders, Drilling machines, etc.		1	Master T&P List with internal & external test details
2l.6	Availability of Tags & Inspection Certificates, colour coding for Wire rope slings etc.		1	Master T&P List with internal & external test details
2l.7	Availability of Tags & Inspection Certificates for Batching plants		1	Master T&P List with internal & external test details

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
2m.1	Use of Lifting Permit as per requirement		1	Permit Records
2m.2	Use of Height Permit as per requirement		1	Permit Records
2m.3	Use of Hot Work Permit as per requirement		1	Permit Records
2m.4	Use of Excavation permit as per requirement		1	Permit Records
2m.5	Use of Confined space work permit as per requirement		1	Permit Records
2m.6	Use of Grating removal and safety net removal permit as per requirement		1	Permit Records
2m.7	Use of Lockout-Tag out permit as per requirement		1	Permit Records
2m.8	Use of Radiography permit as per requirement		1	Permit Records
2m.9	Use of Night/ Holiday Work Permit as per requirement		1	Permit Records
2m.10	Use of Any other Applicable Permit as per requirement		1	Permit Records
3a	Material safety data sheet(MSDS) available for all chemicals and displayed in usage and storage area?		1	Inspection/ non-conformity records
3b	Spillages of oil/concrete and other chemical is controlled and cleaned by proper method in case of spill?		1	Inspection/ non-conformity records
3c	Availability of adequate number of urinals in workplace and in elevations and maintained	M	1	
3d	Availability of rest rooms for workers at site	M	1	
3e	Availability of Drinking water facility at work spot		1	
3f	Hygienic Labour colony is provided for workers.		1	
4a	Is heavy/complex critical lifting permit obtained for heavy, complex materials before handling/erection activity?		1	Work Permit records
4b	Whether area below lifting activities barricaded		1	Inspection/ non-conformity records
4c	Availability of experienced rigging foreman		1	Experience details of rigging foreman
4d	Is agency is following proper storage and handling procedure as per manufacturer standard for all hazardous material?		1	Procedure for storage & handling
4e	Are oxygen and acetylene cylinders are transported to work place from storage area in trolleys		1	
5a	Whether all deep excavation has been protected by barrier		1	Inspection/ non-conformity records
5b	Sloping/benching & shoring provided for excavation as per requirement?		1	-do-
5c	Proper access and egress provided for excavations?		1	-do-
5d	Blasting is done in controlled manner?		2	-do-
6a	Whether Electrical booth is equipped with Co_2 fire extinguishers and fire buckets filled with sand?		2	Inspection/ non-conformity records
6b	Availability of Illumination lamp in electric booth?		1	-do-
6c	whether Caution Boards have been displayed?		1	-do-
6d	Usage of Metal Plug top for all hand power tools ?		1	-do-
6e	Usage of Insulated welding cables.		1	-do-
6f	Electrical Booth/Distribution Board to be covered by proper Canopy.		1	-do-
6g	Availability of functional & individual 30ma ELCB / RCCB and MCB for protection and conducting periodical check-up?		1	-do-
6h	Double earthing for panel boards and all machinery & proper earth pit with regular inspection available?		1	-do-
6i	Whether Electrician is qualified and experienced		1	Qualification & Experience records of electrician
6j	Availability and usage of Rubber hand gloves by electrician?		1	Inspection/ non-conformity records

SL	Parameter for Measurement	M/ O	Wt	Supporting Documents
7a	Whether Scaffolding pipes made with steel or aluminum, are being used and checked periodically by experienced/ certified scaffolder?		2	Inspection/ non-conformity records
7b	8mm Stainless Steel wire rope with plastic cladding is provided for life line (Vertical / Horizontal) during height work?		2	-do-
7c	Availability of emergency lighting in case of power failure		1	-do-
7d	Whether all the openings are covered with Safety Nets made of fire proof Nylon?		1	-do-
7e	Whether MS pipe rails around staircases & platforms in usage are provided with top, middle rails and toe guard ?		1	-do-
7f	Whether Ladder with vertical life line /Fall arrestor is available to climb?		1	-do-
7g	Whether all workers deployed for working at height have been issued height pass after undergoing vertigo test?		1	Height Pass records
7h	Whether all workers deployed for height work / climbing ladder are provided and using Double lanyard safety belt?		1	PPE Issue records, inspection/ non-conformity reports
7i	Is all hand tools/Small material used by height workers is tied firmly to prevent fall?		1	-do-
8a	Flash back arrestors for all gas cutting sets is available on Torch side and cylinder side		1	Inspection/ non-conformity records
8b	Oxygen/Acetylene/LPG cylinders not in use have caps in place and stored separately?		1	-do-
8c	Availability of Face screen, Hand gloves, and Apron, for welders		1	-do-
8d	Protection from falling hot molten metal during metal cutting / welding at height by providing GI sheet below the cutting area especially in fire prone areas		1	-do-
9a	Pre-employment medical check-up done for all workers and submitted?		1	Medical check records
9b	Availability of first aid center, with MBBS doctor(Own or Sharing basis)	**M**	2	Attendance records
9c	Availability of Ambulance facility 24 hours (Own or sharing basis)	**M**	2	-do-
9d	Is First aid trained personnel's are available and their names are displayed at site?	**M**	1	-do-
9e	Availability of Emergency vehicle at site		1	
9f	Periodical medical check-up is conducted for all the workers and submitted?		1	Medical check records
9g	Availability of sufficient number of first aid box as per standard list and maintaining record		1	Inspection records
10a	Availability of Fire extinguishers, buckets at all vulnerable points		2	Fire extinguisher records
10b	Periodic fire mock drill conducted?		1	Fire, Mock drill records
10c	Are all flammable materials are stored separately?		1	
10d	Periodic grass cutting is done in material storage area?		1	
10e	Availability of 24V DC lighting in confined space work area		1	
10f	Availability of exhaust fan in confined space work area		1	

Note:

- **M: Mandatory; O: Optional**. Points other than mandatory can be excluded with appropriate justification (scope etc.) by BHEL
- Additionally: 30 Marks for each Fatal Accident and 10 mark for each major accident shall be deducted.

SAFETY WORK CLEARANCE	Permit no.
Project:	Emergency Contact Nos:
Subcontractor:	

BURNING/WELDING /HOT WORK PERMIT

Area :_____ Date:_____ Time:_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign:_____

Name of Work Performing Contractor: _____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work: _____

_____

Work Execution Date:_____ Time Valid from:_____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Proper Access/Exit available		
2.	Proper ventilation and /or lighting provided.		
3.	Proper and safe scaffolding, platform, ladder provided.		
4.	Welding machine located in a clean and dry area.		
5.	Welding machine grounded at the equipment and proper leakage current protection device (ELCB) provided for welding machine.		
6.	Emergency STOP buttons are in working condition. Welder /Helper knows how to operate it.		
7.	Welding machine input/output cables, welding holder and weld return clamp (Holder) are insulated and in good condition.		
8.	Welder & Fitter trained to connect ground/work return clamps (Holder) to work place prior to energization of welding machine.		
9.	Gas cylinders are stacked vertically and not below the welding / cutting area. Regulator key is available with cylinder.		
10.	Pressure gauges/Flash back arrestor provided and in working condition.		
11.	Personal Protective equipment Minimum applicable: safety helmet, safety goggles, welding helmet, safety shoes, leather gloves, long sleeve and nose mask -provided		
12.	In case of pits, water removed from the pit and wood/rubber insulation provided.		
13.	Safety signboards are in place.		
14.	Adequate and Suitable nos. of fire fighting extinguisher provided.		
15.	Nearby combustible material removed. Housekeeping done.		
16.	Other		

Name of Contractor Safety Officer:_____ Sign:_____ Date:_____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name:_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Safety Representative:_____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority:_____ Sign:_____ Date:_____ Time:_____

Permit Cancellation:

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority:_____ Sign:_____ Date:_____ Time:_____

Name of Site Engr. (Permit Requesting Authority):_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Site Engr. (Permit Issuing Authority):_____ Sign:_____ Date:_____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site **Second Copy – BHEL SAFETY** **Third Copy : Contractor**

SAFETY WORK CLEARANCE	Permit no.
Project:	Emergency Contact Nos:
Subcontractor:	

LIFTING ACTIVITY PERMIT

Area :_____ Date:_____ Time:_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign: Name of Work

Performing Contractor: _____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work: _____

_____

Work Execution Date:_____ Time Valid from:_____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	Crane used for lifting activity tested, certified and approved for rated lifting		
2.	All lifting tackles, gears/appliances are tested and certified for lifting works.		
3.	Crane operator is trained and competent for lifting operation.		
4.	Lifting sling/ belt is protected against sharp edge of the jobs to be lifted.		
5.	Access and exit marked and without obstruction.		
6.	Lifting arrangement adequate.		
7.	Unwanted rubbish material removed from work platform.		
8.	Minimum 2 guidelines have been provided for balancing and guiding jobs to be lifted.		
9.	Periphery area of crane booms as well as lifting job is barricaded and unauthorized/no-entry sign board posted.		
10.	Rigger and signal man is trained and competent for lifting work.		
11.	No lifting activity to be carried out during lightening, heavy wind/rain.		
12.	If scaffolding to be used during lift, scaffolding with valid tag available for use.		
13.	Double lanyards safety harness/belt checked an in working condition.		
14.	Safety shoes (non-slip), helmet with chin strap available with employees.		
15.	Others.		

Name of Contractor Safety Officer:_____ Sign:_____ Date:_____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name:_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Safety Representative:_____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority:_____ Sign:_____ Date:_____ Time:_____

Permit Cancellation:

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority:_____ Sign:_____ Date:_____ Time:_____

Name of Site Engr. (Permit Requesting Authority):_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Site Engr. (Permit Issuing Authority):_____ Sign:_____ Date:_____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site **Second Copy – BHEL SAFETY** **Third Copy : Contractor**

SAFETY WORK CLEARANCE	Permit no.
Project:	Emergency Contact Nos:
Subcontractor:	

WORKING AT HEIGHT PERMIT

Area :_____ Date:_____ Time:_____

Name of Site Engineer (Permit Requesting Authority):_____ Sign: Name of Work

Performing Contractor: _____

Name of Package In charge:_____ Sign:_____ Date:_____

Description of Work: _____

_____

Work Execution Date:_____ Time Valid from:_____ to _____

The above signing person(s) will be responsible to ensure that the above described work will be done under all the safety precautions mentioned on the permit to work.

The following precautions are to be taken:

No.	Item	Yes	Not required
1.	All workers on job are medically fit for working at height (Person should not have vertigo)		
2.	Scaffolding with valid tag available for use		
3.	Safety harness with life line support/ fall arrester are checked and in working condition		
4.	Safety shoes (non-slip), Helmet with chin strip available with employees		
5.	Safety nets are provided as per design and provided 25 ft. below working area & extending 8 ft beyond.		
6.	Horizontal life lines are provided to cater to design specification of 2300kg per person.		
7.	Ladders have been inspected and provided as per BHEL standard/contract.		
8.	All lifting / tightening tools, hand tools/equipment checked and in good condition		
9.	Access and exit marked and without obstruction.		
10.	Lighting arrangement adequate.		
11.	Unwanted and rubbish material removed from working platform.		
12.	Electrical cable, welding Hose/Compressed air hose properly secured and lay down without obstruction.		
13.	Signboards provided on working platforms		
14.	Hazards in the vicinity are identified and communicated to the worker.		
15.	Other		

Name of Contractor Safety Officer:_____ Sign:_____ Date:_____ Time: _____

Reviewed and approved by BHEL Site Engineer (Permit Issuing Authority):

Name:_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Safety Representative:_____ Sign: _____

I understand the precaution to be taken as described above and as per project requirement and hereby confirm that work will be executed under my supervision by following all precaution and Safety Rules.

Name of Work Performing Authority:_____ Sign:_____ Date:_____ Time:_____

Permit Cancellation:

I hereby declare that the work is complete, all workers under my control have been withdrawn and the site restored to safe tidy condition.

Name of Work performing Authority:_____ Sign:_____ Date:_____ Time:_____

Name of Site Engr. (Permit Requesting Authority):_____ Sign:_____ Date:_____ Time:_____

Name of BHEL Site Engr. (Permit Issuing Authority):_____ Sign:_____ Date:_____ Time: _____

(This permit is valid only for the date it is issued)

Original at BHEL site **Second Copy – BHEL SAFETY** **Third Copy : Contractor**

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BHEL

Procedure-2.3

PROCEDURE FOR CONDUCT OF CONCILIATION PROCEEDINGS

1. The proceedings of Conciliation shall broadly be governed by Part-III of the Arbitration and Conciliation Act 1996 or any statutory modification thereof and as provided herein:

2. The party desirous of resorting to Conciliation shall send an invitation/notice in writing to the other party to conciliate specifying all points of Disputes with details of the amount claimed. The party concerned shall not raise any new issue thereafter. Parties shall also not claim any interest on claims/counter-claims from the date of notice invoking Conciliation till the conclusion of the Conciliation proceedings. If BHEL is to initiate Conciliation, then, the invitation to Conciliate shall be extended to the concerned Stakeholder in **Format 7** hereto. Where the stakeholder is to initiate the Conciliation, the notice for initiation of Conciliation shall be sent in **Format-8** hereto.

3. The party receiving the invitation/notice for Conciliation shall within 30 days of receipt of the notice of Conciliation intimate its consent for Conciliation along with its counter-claims, if any.

4. The Conciliation in a matter involving claim or counter-claim (whichever is higher) up to Rs 5 crores shall be carried out by sole Conciliator nominated by BHEL while in a matter involving claim or counter-claim (whichever is higher) of more than Rs 5 crores Conciliation shall be carried out by 3 Conciliators nominated by BHEL. The appointment of Conciliator(s) shall be completed and communicated by the concerned Department/Group of BHEL Unit/Division/Region/Business Group to the other party and the Conciliator(s) within 30 days from the date of acceptance of the invitation to conciliate by the concerned party in the **Format-9**. The details of the Claim, and counter-claim, if any, shall be intimated to the Conciliator(s) simultaneously in **Format-5**.

5. The Parties shall be represented by only their duly authorized in-house executives/officers and neither Party shall be represented by a Lawyer.

6. The first meeting of the IEC shall be convened by the IEC by sending appropriate communication/notice to both the parties as soon as possible but not later than 30 days from the date of his/their appointment. The hearings in the Conciliation proceeding shall ordinarily be concluded within two (2) months and, in exceptional cases where parties have expressed willingness to settle the matter or there exists possibility of settlement in the matter, the proceedings may be extended by the IEC by a maximum of further 2 months with the consent of the Parties subject to cogent reasons being recorded in writing.

7. The IEC shall thereafter formulate recommendations for settlement of the Disputes supported by reasons at the earliest but in any case within 15 days from the date of conclusion of the last hearing. The recommendations so formulated along with the reasons shall be furnished by the IEC to both the Parties at the earliest but in any case within 1 month from the date of conclusion of the last hearing.

8. Response/modifications/suggestions of the Parties on the recommendations of the IEC are to be submitted to the IEC within time limit stipulated by the IEC but not more than 15 days from the date of receipt of the recommendations from the IEC.

9. In the event, upon consideration, further review of the recommendations is considered necessary, whether by BHEL or by the other Party, then, the matter can be remitted back to the IEC with request to reconsider the same in light of the issues projected by either/both the Parties and to submit its recommendations thereon within the following 15 days from the date of remitting of the case by either of the Parties.

10. Upon the recommendations by the Parties, with or without modifications, as considered necessary, the IEC shall be called upon to draw up the Draft Settlement Agreement in terms of the recommendations.

11. When a consensus can be arrived at between the parties only in regard to any one or some of the issues referred for Conciliation the draft Settlement Agreement shall be accordingly formulated in regard to the said Issue(s), and the said Settlement Agreement, if signed, by the parties, shall be valid only for the said issues. As regards the balance issues not settled, the parties may seek to resolve them further as per terms and conditions provided in the contract.

12. In case no settlement can be reached between the parties, the IEC shall by a written declaration, pronounce that the Conciliation between the parties has failed and is accordingly terminated.

13. Unless the Conciliation proceedings are terminated in terms of para 22 (b), (c) & (d) herein below, the IEC shall forward his/its recommendations as to possible terms of settlement within one (1) month from the date of last hearing. The date of first hearing of Conciliation shall be the starting date for calculating the period of 2 months.

14. In case of 3 members IEC, 2 members of IEC present will constitute a valid quorum for IEC and meeting can take place to proceed in the matter after

seeking consent from the member who is not available. If necessary, videoconferencing may be arranged for facilitating participation of the members. However, the IEC recommendations will be signed by all members. Where there is more than one (1) Conciliator, as a general rule they shall act jointly. In the event of differences between the Members of IEC, the decision/recommendations of the majority of the Members of IEC shall prevail and be construed as the recommendation of the IEC.

15. The Draft Settlement Agreement prepared by the IEC in terms of the consensus arrived at during the Conciliation proceedings between the Parties shall be given by the IEC to both the parties for putting up for approval of their respective Competent Authority.

16. Before submitting the draft settlement agreement to BHEL's Competent Authority viz. the Board Level Committee on Alternative Dispute Resolution (BLCADR) for approval, concurrence of the other party's Competent Authority to the draft settlement agreement shall be obtained by the other party and informed to BHEL within 15 days of receipt of the final draft settlement agreement by it. Upon approval by the Competent Authority, the Settlement Agreement would thereafter be signed by the authorized representatives of both the Parties and authenticated by the members of the IEC.

17. In case the Draft Settlement Agreement is rejected by the Competent Authority of BHEL or the other Party, the Conciliation proceedings would stand terminated.

18. A Settlement Agreement shall contain a statement to the effect that each of the person(s) signing thereto (i) is fully authorized by the respective Party(ies) he/she represents, (ii) has fully understood the contents of the same and (iii) is signing on the same out of complete freewill and consent, without any pressure, undue influence.

19. The Settlement Agreement shall thereafter have the same legal status and effect as an arbitration award on agreed terms on the substance of the dispute rendered by an arbitral tribunal passed under section 30 of the Arbitration and Conciliation Act, 1996.

20. Acceptance of the Draft Settlement Agreement/recommendations of the Conciliator and/or signing of the Settlement Agreement by BHEL shall however, be subject to withdrawal/closure of any arbitral and/or judicial proceedings initiated by the concerned Party in regard to such settled issues.

21. Unless otherwise provided for in the agreement, contract or the Memorandum of Understanding, as the case may be, in the event of likelihood of prolonged

absence of the Conciliator or any member of IEC, for any reason/incapacity, the Competent Authority/Head of Unit/Division/Region/Business Group of BHEL may substitute the Conciliator or such member at any stage of the proceedings. Upon appointment of the substitute Conciliator(s), such reconstituted IEC may, with the consent of the Parties, proceed with further Conciliation into the matter either de-novo or from the stage already reached by the previous IEC before the substitution.

22. The proceedings of Conciliation under this Scheme may be terminated as follows:

a. On the date of signing of the Settlement agreement by the Parties; or,

b. By a written declaration of the IEC, after consultation with the parties, to the effect that further efforts at conciliation are no longer justified, on the date of the declaration; or,

c. By a written declaration of the Parties addressed to the IEC to the effect that the Conciliation proceedings are terminated, on the date of the declaration; or,

d. By a written declaration of a Party to the other Party and the IEC, if appointed, to the effect that the Conciliation proceedings are terminated, on the date of the declaration; or,

e. On rejection of the Draft Settlement Agreement by the Competent Authority of BHEL or the other Party.

23. The Conciliator(s) shall be entitled to following fees and facilities:

Sl No	**Particulars**	**Amount**
1	Sitting fees	Each Member shall be paid a Lump Sum fee of Rs 75,000/- for the whole case payable in terms of paragraph No. 27 herein below.
2	Towards drafting of settlement agreement	In cases involving claim and/or counter-claim of up to Rs 5crores. Rs 50,000/- (Sole Conciliator) In cases involving claim and/or counter-claim of exceeding Rs 5 crores but less than Rs 10 crores. Rs 75,000 (per Conciliator)

Sl No	Particulars	Amount
		In cases involving claim and/or counter-claim of more than Rs 10 crores. Rs 1,00,000/- (per Conciliator) Note: The aforesaid fees for the drafting of the Settlement Agreement shall be paid on the, Signing of the Settlement Agreement after approval of the Competent Authority or Rejection of the proposed Settlement Agreement by the Competent Authority of BHEL.
3	Secretarial expenses	Rs 10,000/- (one time) for the whole case for Conciliation by a Sole Member IEC. Where Conciliation is by multi member Conciliators –Rs 30,000/- (one time)- to be paid to the IEC
4	Travel and transportation and stay at outstation Retired Senior Officials of other Public Sector Undertakings (pay scale wise equivalent to or more than E-8 level of BHEL)	As per entitlement of the equivalent officer (pay scale wise) in BHEL.
	Others	As per the extant entitlement of whole time Functional Directors in BHEL. Ordinarily, the IEC Member(s) would be entitled to travel by air Economy Class.
5	Venue for meeting	Unless otherwise agreed in the agreement, contract or the Memorandum of Understanding, as the case may be, the venue/seat of proceedings shall be the location of the concerned Unit / Division / Region /

Sl No	Particulars	Amount
		Business Group of BHEL. Without prejudice to the seat/venue of the Conciliation being at the location of concerned BHEL Unit / Division / Region / Business Group, the IEC after consulting the Parties may decide to hold the proceedings at any other place/venue to facilitate the proceedings. Unless, Parties agree to conduct Conciliation at BHEL premises, the venue is to be arranged by either Party alternately.

24. The parties will bear their own costs including cost of presenting their cases/evidence/witness(es)/expert(s) on their behalf. The parties agree to rely upon documentary evidence in support of their claims and not to bring any oral evidence in IEC proceedings.

25. If any witness(es) or expert(s) is/are, with the consent of the parties, called upon to appear at the instance of the IEC in connection with the matter, then, the costs towards such witness(es)/expert(s) shall be determined by the IEC with the consent of the Parties and the cost so determined shall be borne equally by the Parties.

26. The other expenditures/costs in connection with the Conciliation proceedings as well as the IEC's fees and expenses shall be shared by the Parties equally.

27. Out of the lump sum fees of Rs 75,000/- for Sitting Fees, 50% shall be payable after the first meeting of the IEC and the remaining 50% of the Sitting Fees shall be payable only after termination of the conciliation proceedings in terms of para 22 hereinabove.

28. The travelling, transportation and stay at outstation shall be arranged by concerned Unit as per entitlements as per Serial No. 4 of the Table at para 23 above, and in case such arrangements are not made by the BHEL Unit, the same shall be reimbursed to the IEC on actuals limited to their entitlement as per Serial No. 4 of the Table at Para 23 above against supporting documents. The IEC Member(s) shall submit necessary invoice for claiming the fees/reimbursements.

29. The Parties shall keep confidential all matters relating to the conciliation proceedings. Confidentiality shall extend also to the settlement agreement,

except where its disclosure is necessary for purposes of its implementation and enforcement or as required by or under a law or as per directions of a Court/Governmental authority/ regulatory body, as the case may be.

30. The Parties shall not rely upon or introduce as evidence in any further arbitral or judicial proceedings, whether or not such proceedings relate to the Disputes that is the subject of the Conciliation proceedings:

a. Views expressed or suggestions made by the other party in respect of a possible settlement of the Disputes;

b. admissions made by the other party in the course of the Conciliator proceedings;

c. proposals made by the Conciliator;

d. The fact that the other Party had indicated his willingness to accept a proposal for settlement made by the Conciliator.

31. The Parties shall not present the Conciliator(s) as witness in any Alternative Dispute Resolution or Judicial proceedings in respect of a Disputes that is/was the subject of that particular Conciliation proceeding.

32. None of the Conciliators shall act as an arbitrator or as a representative or counsel of a Party in any arbitral or judicial proceeding in respect of a Disputes that is/was the subject of that particular Conciliation proceeding.

33. The Parties shall not initiate, during the Conciliation proceedings, any arbitral or judicial proceedings in respect of a Disputes that is the subject matter of the Conciliation proceedings except that a Party may initiate arbitral or judicial proceedings where, in his opinion, such proceedings are necessary for preserving his rights including for preventing expiry of period of limitation. Unless terminated as per the provisions of this Scheme, the Conciliation proceedings shall continue notwithstanding the commencement of the arbitral or judicial proceedings and the arbitral or judicial proceedings shall be primarily for the purpose of preserving rights including preventing expiry of period of limitation.

34. The official language of Conciliation proceedings under this Scheme shall be English unless the Parties agree to some other language.

FORMAT-5

STATEMENT OF CLAIMS/COUNTER CLAIMS TO BE SUBMITTED TO THE IEC BY BOTH THE PARTIES

1. Chronology of the Disputes

2. Brief of the Contract/MoU/Agreement/LOI/LOA

3. Brief history of the Disputes:

4. Issues:

5. Details of Clam(s)/Counter Claim(s):

SI. No.	**Description of claim(s)/Counter Claim**	**Amount (in INR)Or currency applicable in the contract**	**Relevant contract clause**

6. Basis/Ground of claim(s)/counter claim(s) (along with relevant clause of contract)

Note– *The Statement of Claims/ Counter Claims may ideally be restricted to maximum limit of 20 pages. Relevant documents may be compiled and submitted along with the statement of Claims/ Counter Claims. The statement of Claims/ Counter Claims is to be submitted to all IEC members and to the other party by post as well as by email.*

FORMAT-7

FORMAT FOR NOTICE INVOKING CONCILIATION CLAUSE BY BHEL FOR REFERRING THE DISPUTES TO CONCILIATION THROUGH IEC

To,

M/s. (Stakeholder's name)

Subject: **NOTICE FOR INVOCATION OF THE CONCILIATION CLAUSE OF THE CONTRACT BY BHEL**

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Dear Sir/Madam,

As you are aware, with reference to above referred Contract/MoU/Agreement/LOI/LOA, certain disputes have arisen, which, in-spite of several rounds of mutual discussions and various correspondences have remained unresolved. The brief particulars of our claims which arise out of the above- referred Contract/MoU/Agreement/LOI/LOA are reproduced hereunder:

Sl. No.	Claim description	Amount involved

As you are aware, there is a provision in the captioned Contract/MoU/Agreement/LOI/ LOA for referring disputes to conciliation.

In terms of Clause ---------of Procedure i.e., Annexure ------ to the Contract/MoU /Agreement / LOI / LOA, we hereby seek your consent to refer the matter to Conciliation by Independent Experts Committee to be appointed by BHEL. You are invited to provide your consent in writing to proceed with conciliation into the above mentioned disputes within a period of 30 days from the date of this letter along with details of counter-claims, if any, which you might have with regard to the subject Contract/ MoU/ Agreement/ LOI/ LOA.

Please note that upon receipt of your consent in writing within 30 days of the date of receipt of this letter by you, BHEL shall appoint suitable person(s) from the BHEL Panel of Conciliators.

This letter is being issued without prejudice to our rights and contentions available under the contract and law.

Thanking you
Yours faithfully

Representative of BHEL

Note: The Format may be suitably modified, as required, based on facts and circumstances of the case.

FORMAT-8

FORMAT FOR NOTICE INVOKING CONCILIATION CLAUSE BY A STAKEHOLDER FOR REFERRING THE DISPUTES TO CONCILIATION THROUGH IEC

To,
BHEL (Head of the Unit/Division/Region/Business Group)

Subject: **NOTICE FOR INVOCATION OF THE CONCILIATION CLAUSE OF THE CONTRACT BY A STAKEHOLDER**

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Dear Sir/Madam,

As you are aware, with reference to above referred Contract/MoU/Agreement/LOI/LOA, certain disputes have arisen, which, in-spite of several rounds of mutual discussions and various correspondences have remained unresolved. The brief particulars of our claims which have arisen out of the above-referred Contract/MoU/Agreement/LOI/LOA are enumerated hereunder:

Sl. No.	Claim description	Amount involved

As you are aware, there is a provision in the captioned Contract/MoU/Agreement/LOI/ LOA for referring inter-se disputes of the Parties to conciliation.

We wish to refer the above-said disputes to Conciliation as per the said Clause of the captioned Contract/MoU/Agreement/LOI/ LOA. In terms of Clause ---------of Procedure i.e., Annexure ------ to the Contract/MoU /Agreement / LOI / LOA, we hereby invite BHEL to provide its consent in writing to proceed with conciliation into the above mentioned disputes within a period of 30 days from the date of this letter along with details of counter-claims, if any, which it might have with regard to the subject Contract/ MoU/ Agreement/ LOI/ LOA and to appoint suitable person(s) as Conciliator(s) from the BHEL Panel of Conciliators.

This letter is being issued without prejudice to our rights and contentions available under the contract and law.

Thanking you
Yours faithfully

Representative of the Stakeholder

Note: The Format may be suitably modified, as required, based on facts and circumstances of the case.

FORMAT-9

FORMAT FOR INTIMATION TO THE STAKEHOLDER ABOUT APPOINTMENT OF CONCILIATOR/IEC

To,

M/s. (Stakeholder's name)

Subject: **INTIMATION BY BHEL TO THE STAKEHOLDER AND CONCILIATOR(S) ABOUT APPOINTMENT OF CONCILIATOR/IEC**

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Sir,

This is with reference to letter dated ---------- regarding reference of the disputes arising in connection with the subject Contract No /MoU/Agreement/LOI/LOA to conciliation and appointment of Conciliator(s).

In pursuance of the said letter, the said disputes are assigned to conciliation and the following persons are nominated as Conciliator(s) for conciliating and assisting the Parties to amicably resolve the disputes in terms of the Arbitration & Conciliation Act, 1996 and the Procedure ---- to the subject Contract ...../MoU/Agreement/LOI/LOA, if possible.

Name and contact details of Conciliator(s)

a) .....

b) .....

c) .....

You are requested to submit the Statement of Claims or Counter-Claims (strike off whichever is inapplicable) before the Conciliator(s) in Format 5 (enclosed herewith) as per the time limit as prescribed by the Conciliator(s).

Yours faithfully,

Representative of BHEL

CC: To Conciliator(s)… for Kind Information please.
Encl: As above

Note: The Format may be suitably modified, as required, based on facts and circumstances of the case.

Form WAM 23

PROFORMA OF BANK GUARANTEE (in lieu of EARNEST MONEY if permissible under Works Policy)

(On non-Judicial paper of appropriate value)
(Para 4.7.6 of Works Accounts Manual)

Bank Guarantee No……
Date……

To
(Employer's Name and Address)
……..

Dear Sirs,

In accordance with the terms and conditions of Invitation for Bids/Notice Inviting Tender No……[1] (Tender Conditions), M/s. ……[2] having its registered office at ……[3] (hereinafter referred to as the 'Tenderer'), is submitting its bid for the work of……[4] invited by Bharat Heavy Electricals Limited (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at *BHEL House, Siri Fort, Asiad, New Delhi – 110049* through its unit at *Bharat Heavy Electricals Limited, Power Sector Southern Region, Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai – 600097.*

The Tender Conditions provide that the Tenderer shall pay a sum of Rs ……[5] as Earnest Money Deposit in the form therein mentioned. The form of payment of Earnest Money Deposit includes Bank Guarantee executed by a Scheduled Bank.

In lieu of the stipulations contained in the aforesaid Tender Conditions that an irrevocable and unconditional Bank Guarantee against Earnest Money Deposit for an amount of .....[6] is required to be submitted by the Tenderer as a condition precedent for participation in the said Tender and the Tenderer having approached us for giving the said Guarantee,

we, the .....(Name & address of the Bank) ..... having our Head Office at ……..(hereinafter referred to as the Bank) being the Guarantor under this Guarantee, hereby irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer without any demur, merely on your first demand any sum or sums of Rs.....[6] (in words Rupees.....) without any reservation, protest, and recourse and without the beneficiary needing to prove or demonstrate reasons for its such demand.

Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____.[6]

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Tenderer in any suit or proceeding pending before any Court or Tribunal, Arbitrator or any other authority, our liability under this present being absolute and unequivocal.

The payment so made by us under this Guarantee shall be a valid discharge of our liability for payment hereunder and the Tenderer shall have no claim against us for making such payment.

We …….. Bank further agree that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said Tender or to extend the time of submission of from time to time or to postpone

for any time or from time to time any of the powers exercisable by the Employer against the said Tenderer and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said Tenderer or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said Tenderer or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Tenderer and notwithstanding any security or other guarantee that the Employer may have in relation to the Tenderer's liabilities.

This Guarantee shall be irrevocable and shall remain in force upto and including…….[7] and shall be extended from time to time for such period as may be desired by the Employer.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Tenderer but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms hereof. However, unless a demand or claim under this Guarantee is made on us in writing on or before the ……[8] we shall be discharged from all liabilities under this Guarantee.

We, …… Bank lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.
Notwithstanding anything to the contrary contained hereinabove:

a) The liability of the Bank under this Guarantee shall not exceed……[6]
b) This Guarantee shall be valid up to ……[7]
c) Unless the Bank is served a written claim or demand on or before _____[8] all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

For and on behalf of
(Name of the Bank)

(Signature of Authorised signatory)

Date…….
Place of Issue…….

[1] Details of the Invitation to Bid/Notice Inviting Tender (Tender Ref. No. Eg. - BHEL PSSR SCT XXXX)
[2] Name of Tenderer
[3] REGISTERED Office Address of the Tenderer
[4] Details of the Work i.e Tender Description
[5] EMD Amount as mentioned in Notice Inviting Tender
[6] BG Amount in words and Figures (BG Amount shall be Minimum of EMD amount less Rs. 2 Lakhs)
[7] Validity Date
[8] Date of Expiry of Claim Period (Claim Period shall be minimum of 3 Months after the validity date of Bank Guarantee)

Note:
1. The BG should be on Non-Judicial Stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the State(s) where the BG is submitted or is to be acted upon or the rate prevailing in the State where the BG was executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Vendor/Contractor/Supplier /Bank issuing the guarantee.

2. In Case of Bank Guarantees submitted by Foreign Vendors-
   a. From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India) can be accepted subject to the condition that the Bank Guarantee should be enforceable in the town/city or at nearest branch where the Unit is located i.e. Demand can be presented at the Branch located in the town/city or at nearest branch where the Unit is located.
   b. From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor Country's Bank)
      b.1 In such cases, in the Tender Enquiry/ Contract itself, it may be clearly specified that Bank Guarantee issued by any of the Consortium Banks only will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter- Guarantee by Foreign Bank in favour of the Indian Bank's (BHEL's Consortium Bank) branch in India. It is advisable that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor. The tender stipulation should clearly specify these requirements.
      b.2 In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. b.1 will required to be followed.
      b.3 The BG issued may preferably be subject to Uniform Rules for Demand Guarantees (URDG) 758 (as amended from time to time).

PROFORMA OF BANK GUARANTEE (in lieu of SECURITY DEPOSIT)
(On non-Judicial paper of appropriate value)
(Para 4.7.6 of Works Accounts Manual)

Bank Guarantee No……
Date……

To
(Employer's Name and Address)
……..

In consideration of Bharat Heavy Electricals Limited (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at *BHEL House, Siri Fort, Asiad, New Delhi – 110049* through its unit at *Bharat Heavy Electricals Limited, Power Sector Southern Region, Tek Towers, No.11, Old Mahabalipuram Road, Okkiyam Thoraipakkam, Chennai - 600097* having agreed to exempt _____[1] (Name of the Vendor / Contractor / Supplier) with its registered office at_____[2] (hereinafter called the said "Contractor" which term includes supplier), from demand under the terms and conditions of the Contract arising vide Letter of Intent (LOI) reference No._____ dated _____[3] valued at Rs. _____[4] (Rupees _____ only)[4] (hereinafter called the said Contract), of Security Deposit for the due fulfilment by the said Contractor of the terms and conditions contained in the said Contract, on production of a Bank Guarantee for Rs. _____[5] (Rupees _____ only),

We, the .....(Name & address of the Bank) ..... having our Head Office at ……..(hereinafter referred to as the Bank), at the request of _____ [Contractor(s)], being the Guarantor under this Guarantee, do hereby irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer, an amount not exceeding Rs._____ without any demur, immediately on demand from the Employer and without any reservation, protest, and recourse and without the Employer needing to prove or demonstrate reasons for its such demand

Any such demand made on the bank, shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs. _____[5].

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Contractor(s) in any suit or proceeding pending before any Court or Tribunal or Arbitrator or any other authority, our liability under this present being absolute and unequivocal.

The payment so made by us under this guarantee shall be a valid discharge of our liability for payment hereunder and the Contractor(s) shall have no claim against us for making such payment.

We, further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Contract and that it shall continue to be enforceable till all the dues of the Employer under or by virtue of the said Contract have been fully paid and its claims satisfied & the Employer certifies that the terms and conditions of the said Contract have been fully and properly carried out by the said contractor(s) or acceptance of the final bill or discharge of this guarantee by the Employer, whichever is earlier. This guarantee shall initially remain in force upto and including _____[6] and shall be extended from time to time for such period as may

be desired by the Employer. Unless a demand or claim under this guarantee is made on us in writing on or before the _____[7], we shall be discharged from all the liability under this guarantee thereafter.

We, _____(indicate the name of the Bank) further agree with the Employer that the Employer shall have the fullest liberty without our consent and without affecting in any manner our obligations hereunder to vary any of the terms and conditions of the said Contract or to extend time of performance by the said contractor(s) from time to time or to postpone for any time or from time to time any of the powers exercisable by the Employer against the said contractor(s) and to forbear or enforce any of the terms and conditions relating to the said Contract and we shall not be relieved from our liability by any reason of any such variation or extension being granted to the said contractor(s) or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said contractor(s) or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee that the Employer may have in relation to the Contractor's liabilities.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Contractor but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms thereof. This guarantee will not be discharged due to the change in the constitution of the Bank or the Contractor(s).

We, ……. BANK lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.
Notwithstanding anything to the contrary contained hereinabove:

a) The liability of the Bank under this Guarantee shall not exceed……[5]

b) This Guarantee shall be valid up to ……[6]

c) Unless the Bank is served a written claim or demand on or before _____[7] all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank.

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

Date _____ Day of _____

for_____ (indicate the name of the Bank)

(Signature of Authorised signatory)

[1] NAME OF VENDOR /CONTRACTOR / SUPPLIER
[2] REGISTERED OFFICE ADDRESS OF THE VENDOR /CONTRACTOR / SUPPLIER.
[3] LETTER OF INTENT(LOI) REFERENCE NO. WITH DATE
[4] CONTRACT VALUE (AS MENTIONED IN LOI)
[5] BG AMOUNT IN FIGURES AND WORDS
[6] VALIDITY DATE
[7] DATE OF EXPIRY OF CLAIM PERIOD (CLAIM PERIOD SHALL BE MINIMUM OF 3 MONTHS AFTER VALIDITY DATE)

Note:

1. The BG should be on Non-Judicial Stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the State(s) where the BG is submitted or is to be acted upon or the rate prevailing in the State where the BG was executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Vendor/Contractor/Supplier /Bank issuing the guarantee.
2. In Case of Bank Guarantees submitted by Foreign Vendors-
   a. From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India) can be accepted subject to the condition that the Bank Guarantee should be enforceable in the town/city or at nearest branch where the Unit is located i.e. Demand can be presented at the Branch located in the town/city or at nearest branch where the Unit is located.
   b. From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor Country's Bank)
      b.1 In such cases, in the Tender Enquiry/ Contract itself, it may be clearly specified that Bank Guarantee issued by any of the Consortium Banks only will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter- Guarantee by Foreign Bank in favour of the Indian Bank's (BHEL's Consortium Bank) branch in India. It is advisable that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor. The tender stipulation should clearly specify these requirements.

      b.2 In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. b.1 will required to be followed.
      b.3 The BG issued may preferably be subject to Uniform Rules for Demand Guarantees (URDG) 758 (as amended from time to time).

PSSR	MONTHLY PLAN & REVIEW WITH CONTRACTOR	Page **1** of **6**

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART- A: PLAN/ REVIEW OF WORK FOR THE MONTH OF …….. Date of Plan/ Review……

SN.	Description of Work	Unit of Measur-ement	Unit Rate	Planned (QTY Planned for the month as per Part –C of last month)		Cumulative Shortfall attributable to contractor upto last month (Refer Note 1)		Achieved		Shortfall attributable to BHEL w.r.t Plan (as per Col. 3 of Part-D)		Cumulative Shortfall attributable to Contractor upto & including this month		REMARKS (Reasons for Shortfall attributable to Contractor. Supporting documents to be kept as record.)
(a)	(b)	(c)	(d)	A		B		C		D		E=A+B-C-D		
				Phy.	Financial	Phy	Financial	Phy.	Financial	Phy.	Financial	Phy.	Financial	
	Value of Other Items not mentioned above but planned to be executed in this month													
Total					ΣA		ΣB		ΣC		ΣD		ΣE	

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART- A: Contd…….

Note 1: **In addition to the work planned as per Col. 'A', Contractor shall also make full efforts to minimize the 'Cumulative shortfall attributable to contractor upto the month' as mentioned in Col. 'B' by enhancing its resources, so as to achieve the completion of activities as per agreed schedule. In case contractor is not able to execute the entire shortfall, then BHEL 'Engineer in-charge', shall decide the priority of work to be executed and it shall be binding on the contractor.**

Note 2: Percentage Shortfall attributable to contractor w.r.t. **"**Plan - Shortfall attributable to BHEL**"** for the month = [(ΣE-ΣB)/(ΣA-ΣD)]x100
In case, (ΣE-ΣB) is negative, then it shall be treated as zero percent."

Note 3: Form 14 should include all items being planned in the current month, and all items against which shortfall was attributable to contractor till previous month. However, for practical reason, if it is not possible to mention some of the items in Form-14 being planned to be executed in this month, then also value of such items shall necessarily be included in calculation of Total Value.

Note 4: In case reason for shortfall attributable to contractor is w.r.t. T&P and Manpower, it should be in conformity with Part B1 and B2.

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – B-1: PLAN/REVIEW OF DEPLOYMENT OF MAJOR T&Ps FOR THE MONTH OF ……..…….. Date of Plan/ Review……

CONTRACTOR'S SCOPE: -

SN.	PLAN				DEPLOYMENT STATUS			
	Major T&P to be deployed as per work planned for the month	QTY	Deployment Period (in days)	Weightage assigned to planned T&P (in fraction such that ΣC =1)	Actual Deployed Quantity	Actual Deployment Period (in days)	Weighted T&P Deployed	REMARKS (Works affected due to non-deployment of T&Ps)
		A	B	C	D	E	F=(C x D x E) / (A x B)	

Note: In case, E>B, it shall be considered as E=B. Similarly, in case D>A, it shall be considered as D=A.
Percentage of T&P Deployed = ΣF x 100

BHEL SCOPE: -

SN.	PLAN			DEPLOYMENT STATUS		
	Major T&P to be deployed as per work planned for the month	QTY	Deployment Period (in days)	Actual Deployed Quantity	Actual Deployment Period (in days)	REMARKS (Works affected due to non-deployment of T&Ps)

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – B-2: PLAN/ REVIEW OF DEPLOYMENT OF MANPOWER FOR THE MONTH OF ……..…….. Date of Plan/ Review……

CONTRACTOR'S SCOPE: -

SN.	Area of Work	Category of Labour	No. of Labour required as per category	Deployment Period (in days)	No. of Labour actually deployed	Actual Deployment Period (in days)	REMARKS (Works affected due to non-availability of labour)
			A	B	C	D	

Percentage of Manpower Deployed=100 x Σ(CxD)/Σ(AxB)

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

PSSR	MONTHLY PLAN & REVIEW WITH CONTRACTOR	Page **5** of **6**

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – C: PLAN(PHYSICAL) FOR THE NEXT MONTH i.e. ……..…….. Date of Plan ……

SN.	Description of work	Original Planned Quantity	Planned Quantity (excluding shortfalls attributable to contractor till date)	Unit of Measu-rement	T&Ps Required				Manpower Required		REMARKS (Reasons for difference in Original Planned Quantity w.r.t. Planned quantity to be given)
					Contractor Scope		BHEL Scope		Category of Labour	No. of Labour required as per Category	
					Major T&P to be deployed as per work planned for the month	Quantity	Major T&P to be deployed as per work planned for the month	Quantity			

Note 1: Planned quantity should be based on available/ expected fronts/ inputs in the next month

Note 2: "Original Planned Quantity" shall be as per latest jointly agreed programme between BHEL and Contractor before commencement of work or at the time of latest Time Extension, as the case may be.

BHEL
(Sign with name, designation and date)

CONTRACTOR
(Sign with name, designation and date)

Name of Project		Contract No.	
Name of Work		Name of Contractor	

PART – D: REASONS FOR SHORTFALL ATTRIBUTABLE TO BHEL IN RESPECT OF PLAN FOR THE MONTH……

SN.	Description of Work (from Part-A)	Quantities Affected		Reasons for Shortfall attributable to BHEL	Agency responsible for reasons for Shortfall	Remarks (Supporting Documents in respect of agency responsible)
		(Physical Quantity)	Unit of Measu-rement			
1	2	3	4	5	6	7

Note1: Reasons for shortfall shall include non-availability of fronts/ drawings/ materials/ T&P (BHEL Scope)/ clearances etc. and other hindrances for which contractor is not responsible.

Note2: Agency responsible may be BHEL Site/ MUs/ Design Centre/ BHEL Customer/ other Contractors etc.

BHEL
(Sign with name, designation and date)

Project		**Vendor**			**Package/Unit**	
Sl. No.	Parameter for Measurement	Classification	Max Score	Score Obtained	Measurement Key/Scheduled date	Supporting Documents
#1.01	Cumulative number of days in the month, the nominated Quality Officer or his authorised nominee was not available	QUALITY	1.5		Quality Officer or his authorised nominee should be available for all the days of working at site	Daily Log Book entry/Incident Registers/letter references
#1.02	Number of instances of non- compliance wrt FQP, Standard Drawings, Specifications, E&C Manuals etc.	QUALITY	1.5		No deviation from FQP, Standard Drawings, Specifications, E&C Manuals etc. is allowed without BHEL Engineer's approval.	Daily Log Book entry/Incident Registers/letter references
#1.03	Percentage submission of test certificates for batches of welding electrodes, cement, sand, aggregate, consumable, Paints etc. as applicable for this month OR In case of MM & MH package, monthly checks for Storage/Preservation of material.	QUALITY	1		Submission of 100% Test certificates for materials as per FQP is mandatory. MM & MH package: Storage/Preservation as per manual/procedure.	Daily Log Book entry/Incident Registers/letter references
#1.04	Number of incidences of improper storage & preservation (not in accordance to the guidelines of BHEL MUs or approved FQP) of materials, consumables (viz. gases, welding electrodes & fluxes, fuel etc.) & bought-out items (paints, fasteners etc.) under the custody of the contractor	QUALITY	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#1.05	Rework/ Rejection instances in a month necessitated due to deviation from Standard Drawings /Specifications /Manuals /E&C procedures /FQPs or due to Poor Workmanship by contractor	QUALITY	2		Reworks/ Rejection should be as minimum as possible. Total number of reworks/ rejections due to reasons attributable to contractor.	Daily Log Book entry/Incident Registers/letter references
#1.06	Delay in preparation & submission of signed protocols / log sheets / site register / NDT test reports as per approved FQP/ Qualified Welder List along with photocopies of Welder ID cards / Welder Performance Evaluation records etc. in the month OR in case of MM / MH package reconciliation statement / verification report.	QUALITY	1		Within 2 days of measurements taken or within first 3 working days of next month, as advised by BHEL Engineer	Daily Log Book entry/Incident Registers/letter references
#1.07	Number of instances for Major equipment/product failure due to negligence/improper work/poor workmanship by contractor	QUALITY	1		No such event should happen	Daily Log Book entry/Incident Registers/letter references
#1.08	Total number of complaints received in the month on the quality of finish / aesthetics	QUALITY	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references

Name and Signature of BHEL Package In-charge

Name and Signature of Contractor

Project		**Vendor**			**Package/Unit**	
Sl. No.	Parameter for Measurement	Classification	Max Score	Score Obtained	Measurement Key/Scheduled date	Supporting Documents
#2.01	Cumulative number of days of delay in submission of Plan FOR THE MONTH supported by deployment plan of Major T&Ps and Manpower (as per Form F-14) and relevant construction/layout drawings - like A4 plan / elevation views of plan status for structures / pressure parts/Civil Works, Piping isometrics for piping, Layout / PID / System reference sketch, Unloading / storage plans etc.as applicable.	PERFORMANCE	5		Number of days delayed from second working day of the month	Daily Log Book entry/Incident Registers/letter references
#2.02	Percentage of timely submission of Daily Reports for Progress of work, Resources, Consumables etc.	PERFORMANCE	1.5		Percentage of timely submission of daily reports/ Scheduled date is successive next day for each day	Daily Log Book entry/Incident Registers/letter references
#2.03	Number of days delayed for submission of FQP log sheets / protocols / Monthly Progress Reports for the work executed during the month under measurement	PERFORMANCE	1.5		Number of days delayed/Scheduled date is first 2 working days of next month	Daily Log Book entry/Incident Registers/letter references
#2.04	Percentage Shortfall attributable to contractor w.r.t. “Plan - Shortfall attributable to BHEL” for the month as per Form-14	PERFORMANCE	35		As per Part-A of Form-14	Progress review formats
#2.05	Number of days delayed in submission of Running bills with complete supporting documents (including updated reconciliation statement of BHEL issued material) for the month	PERFORMANCE	2		Number of days delayed / Scheduled date is 7th day of next month	Daily Log Book entry/Incident Registers/letter references
#2.06	Number of times the Top Management of contractor did not respond to critical issues of site, for the month	PERFORMANCE	1		Total number of instances	Daily Log Book entry/Incident Registers/letter references
#2.07	Cumulative number of days in the month the works were stopped / refused on interpretation of contract clauses/scope due to tendency of taking undue advantage by interpreting contract clauses in their favour	PERFORMANCE	2		Cumulative number of days lost	Daily Log Book entry/Incident Registers/letter references
#2.08	Number of times rework was refused by contractor	PERFORMANCE	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references

Project		**Vendor**			**Package/Unit**	
Sl. No.	Parameter for Measurement	Classification	Max Score	Score Obtained	Measurement Key/Scheduled date	Supporting Documents
#2.09	Cumulative number of days in the month recording / logging was not done in daily log / history register / hindrance register / soft form in a PC maintained at BHEL Site Office	PERFORMANCE	1		Cumulative number of days recording or logging was not done / all days of the month	Daily Log Book entry/Incident Registers/letter references
#3.01	Percentage of Manpower Deployed w.r.t. Plan for the month as per Form-14.	RESOURCES	7		As per Part-B2 of Form-14	Daily Log Book entry/Incident Registers/letter references
#3.02	Percentage of T&P Deployed w.r.t. Plan for the month as per Form-14.	RESOURCES	7		As per Part-B1 of Form-14	Daily Log Book entry/Incident Registers/letter references
#3.03	Cumulative number of major instances in the month hampering / affecting progress of work due to breakdown or non-availability of major T&P and MME for the work, under the scope of Contractor	RESOURCES	3		Cumulative number of instances	Daily Log Book entry/Incident Registers/letter references
#3.04	Cumulative number of major instances in the month hampering / affecting progress of work due to non-availability of Consumables/ use of improper consumables under the scope of contractor	RESOURCES	3		Cumulative number of instances	Daily Log Book entry/Incident Registers/letter references
#4.01	Number of non-compliances during the month for Statutory requirements like validity of Labour Licence, Insurance Policy, Labour Insurance, PF, BOCW Compliance etc. and any other applicable laws/ Regulation, Electrical Licence, T&P fitness certificate, Contractors' All Risk Policy etc. as applicable	SITE INFRASTRUCTURE & SERVICE	1		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#4.02	Cumulative number of days in a month poor illumination is reported at storage area, erection area, pre-assembly area and other designated areas by BHEL site.	SITE INFRASTRUCTURE & SERVICE	0.5		Total number of non-compliances/random checks	Daily Log Book entry/Incident Registers/letter references
#4.03	Cumulative number of days of non-availability of well-maintained toilets facilities for workers (separate for men and women) and non-availability of potable drinking water stations for workers in specified areas.	SITE INFRASTRUCTURE & SERVICE	1		Total number of non-compliances/random checks	Daily Log Book entry/Incident Registers/letter references

Project		**Vendor**			**Package/Unit**	
Sl. No.	Parameter for Measurement	Classification	Max Score	Score Obtained	Measurement Key/Scheduled date	Supporting Documents
#4.04	Total number of instances in the month, Housekeeping NOT attended to in spite of instructions by BHEL -i.e. removal / disposal of surplus earth / debris / scrap / unused / surplus cable drums / other electrical items / surplus steel items / packing materials, thrown out scrap like weld butts, cotton waste etc. from the working area to identified locations	SITE INFRASTRUCTURE & SERVICE	2		Total number of non-compliances/random checks	Daily Log Book entry/Incident Registers/letter references
#4.05	Total number of instances in a month, Site Office with reasonably good facilities including enough nos. of computers and printers etc. for use by office and supporting staff was not made available/maintained.	SITE INFRASTRUCTURE & SERVICE	0.5		No discrepancy during regular or surprise visits	Photograph and report of the Engineer
#5.01	Number of days delayed in making labour payments for the last month	SITE FINANCE	2		Number of days delayed / Scheduled date is 7th day of next month	Daily Log Book entry/Incident Registers/letter references
#5.02	Number of complaints from labour/ sub supplier/ sub-contractor for non-receipt of payments from contractor	SITE FINANCE	1.5		Total number of complaints or reporting	Daily Log Book entry/Incident Registers/letter references
#5.03	Number of times the site operations were hampered for want of funds at the disposal of site-in-charge.	SITE FINANCE	1.5		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#6.01	Cumulative number of days in a month the nominated Safety Officer was not available	HSE & SA	1		Safety Officer should be available for all the days	Daily Log Book entry/Incident Registers/letter references
#6.02	Shortfall in number of weekly safety meetings in the month conducted or attended by the Safety Officer	HSE & SA	0.5		Safety meetings to be held every week	Copy of Minutes of meeting
#6.03	Level of compliance w.r.t decisions taken in previous Safety meetings	HSE & SA	0.5		Number of consolidated issues discussed in Safety meetings	Copy of Minutes of meeting, Non-compliance intimation documents from BHEL site
#6.04	Delay in submission of monthly report on safety (including electrical safety for equipment & personnel etc.) in the prescribed form	HSE & SA	1		Number of days delayed/Scheduled date is third working day of next month	Daily Log Book entry/Incident Registers/letter references
#6.05	Number of days taken for lodging FIRs from date of occurrence/notice of incident of theft / accident etc.	HSE & SA	0.5		Number of days delayed/Scheduled date is within 24 Hrs of occurrence/notice of incidence	Copy of FIR lodged by Contractor

Project		**Vendor**			**Package/Unit**	
Sl. No.	Parameter for Measurement	Classification	Max Score	Score Obtained	Measurement Key/Scheduled date	Supporting Documents
#6.06	Number of times written(email, letters etc.) warning issued for non-availability/ use of improper Fall protection and rescue arrangement as lifeline, fall arrestors, safety net, hand-railings, covered floors, man-basket, rescue basket & kit etc. by the contractor	HSE & SA	2		Total number of non-compliances	Daily Log Book entry/Incident Registers/letter references
#6.07	Number of times punitive fines imposed for unsafe practices as per contract like non-availability/use of PPEs as safety shoes, helmets, goggles, gloves, lifeline, safety belts etc.	HSE & SA	1		Total number of non-compliances	Non-compliance intimation documents from BHEL site
#6.08	Percentage compliance to Emergency preparedness and response plan: Portable Fire-extinguishers, Buckets, Fire-wardens, display of emergency numbers, mock-drills, Hazard Identification and Risk Assessment(HIRA) etc.	HSE & SA	1		Compliance should be 100% as per HSE Plan or as finalized in Safety Meetings	Non-compliance intimation documents from BHEL site
#6.09	Number of times the agency has defaulted on display of safety posters / safety slogans / safety barriers/emergency numbers etc. in identified areas	HSE & SA	0.5		Total number of instances	Non-compliance intimation documents from BHEL site
#6.10	Non compliances observed during HSE and Safety Audit	HSE & SA	0.5		Total number of non-compliances	Non-compliance intimation documents from BHEL site, Audit Reports
#6.11	Cumulative number of days in the month, non-availability of First Aid Kit, First Aider & Emergency Vehicles/Ambulance.	HSE & SA	0.5		Cumulative number of days	Non-compliance intimation documents from BHEL site
#6.12	Number of days taken for submission of Root Cause analysis (RCA) for the accident from the cut-off date intimated by BHEL for submission of RCA	HSE & SA	0.5		Number of days delayed/Scheduled date is cut-off date intimated by BHEL	Daily Log Book entry/Incident Registers/letter references
#6.13	Non conductance of training (induction, job specific, height work etc.), tool box meeting and health check-up as per Contract requirements	HSE & SA	0.5		Number of incidences of non-conductance during the month	Daily Log Book entry/Incident Registers/letter references
		Total	100			

Name and Signature of BHEL Package In-charge

Name and Signature of Contractor

Project		**Vendor**			**Package/Unit**	
Sl. No.	Parameter for Measurement	Classification	Max Score	Score Obtained	Measurement Key/Scheduled date	Supporting Documents
Less Deduction in Score Due to Major Accidents (Fatal, Permanent Disability or bodily injury by which person injured is prevented to resume to work within 48 hours or more after accident,, Major Damage to Equipment etc.) attributable to the contractor @ 3 points/ accident						
Less Deduction in Score Due to Minor Accidents attributable to the contractor @ 1 point/ accident						
Less Deduction in Score Due to not Maintaining of Labour Colony (if applicable) as per BHEL HSE policy @2 points in a month on verification any day						
				Final Score		

Performance Score Summary for the Month	Total Score	Score Obtained
QUALITY	10	
PERFORMANCE	50	
RESOURCES	20	
SITE INFRASTRUCTURE & SERVICE	5	
SITE FINANCE	5	
HSE & SA	10	
OTHERS (deductions if any)	0	
TOTAL	**100**	

Note:

1) It is only indicative and shall be as per the online format issued by BHEL time to time.
2) No request will be entertained after specified date of current month w.r.t. changes requested in the scores of immediate previous month.

Name and Signature of BHEL Package In-charge

Name and Signature of Contractor