## I. INTRODUCTION:

This document is intended for Pre-tender tie-up for Civil, Structural and Architectural works for RAW MATERIAL HANDLING SYSTEM of NMDC 3 MTPA Integrated Steel Plant at Nagarnar, Chattisgarh. The bidder is expected to study the enclosed document and ensure complete scope for Civil Works as per the specification on a turnkey basis for RMHP facilities.

The civil works is divided in the two packages as below:

| | |
|---|---|
| Package-A | Civil Works for Silos in Raw Material Handling Plant |
| Package-B | Civil Works for Coal Handling Plant, Ore Handling Plant and other Facilities **excluding Silos** |

## Package-A : Civil Works for Silos in Raw Material Handling Plant

### I SCOPE OF WORK

Construction of RCC Silos in slip form technique.

In addition to the silos, the following civil works shall also be included in the bidder's scope

1. Construction of open storage yard of minimum size of 200M x 100M with barbed wire fencing security gate required approach of compacted ground for storage of steel etc.. roads pathways with all sleepers and illumination external lighting all as per construction of covered store building of minimum size.15M x 30M x 6M height with GI sheet roof on supported on structural columns with all facilities as per NIT spec.

2. Construction office building for BHEL/ISG. Use of minimum size 24M x 12M x 3M with required partition toilets lighting, A/C, etc as per approved drawing.

### II DETAILED SCOPE OF WORK

| Sl No | Description | Unit | Qty |
|---|---|---|---|
| | **CONSTRUCTION OF RCC SILOS** | | |
| A) | Design, Engineering, Supply & construction of RCC silos with supporting column, beams, supporting structures with concrete including connecting Walkways Complete.<br>(Total Silos 73 nos ) | | |
| 1 | Sinter 30mm EV-500 $m^3$ excluding freeboard | Nos | 16 |
| 2 | Coal 30mm EV-1550 $m^3$ excluding freeboard | Nos | 16 |
| 3 | Coke fines 3mm EV-300 $m^3$ excluding freeboard | Nos | 16 |
| 4 | M/S 3mm EV-150 $m^3$ excluding freeboard | Nos | 1 |
| 5 | F.D. 1mm EV-150 $m^3$ excluding freeboard | Nos | 1 |
| 6 | L.S. 50mm EV-450 $m^3$ excluding freeboard | Nos | 8 |
| 7 | Slag EV-100 $m^3$ excluding freeboard | Nos | 1 |
| 8 | Lump Ore 25mm EV-300 $m^3$ excluding freeboard | Nos | 3 |
| 9 | L/S 50MM EV-600 $m^3$ excluding freeboard | Nos | 8 |
| 10 | Nut Coke 8-34mm EV-450 $m^3$ excluding freeboard | Nos | 1 |
| 11 | Coke fines 8mm EV-450 $m^3$ excluding freeboard | Nos | 1 |
| 12 | OF. 10mm EV-400 $m^3$ excluding freeboard | Nos | 1 |
| **B)** | Miscellaneous Works such as Open Temporary storage yard with fencing and covered stores, Power and construction water, Illumination, Temporary Roads and Drains. Cable bridge foundation | **Lot** | 1 |
| | **TOTAL** | | |

Note : EV – Effective Volume

**Package-B : Civil Works for Coal Handling Plant, Ore Handling Plant and other Facilities excluding Silos**

## I BROAD SCOPE OF WORK

Major **Civil Works excluding Coal blending Silos** for installation of Raw Material Handling Plant facilities package shall pertain to the following areas:

a) Wagon tippler with RCC hoppers and 60 kg / m rail.
b) Track hopper with all facilities including 60 kg / m rail on top of track hopper.
c) Various storage beds for ore, coal, base mix etc. complete with 60 kg / m rail and foundation for same required for the yard equipment and transfer track, suitable drains and drain-pits.
d) Various Hammer kills, Rod mills and screens for Coal preparation, crushing/ screening of ingredients for Base mix preparation, screening of Iron Ore lump and Lime/ Dolo of SMS grade with foundations and vibration-isolation system for the same.
e) Various buildings like Storage Bins, junction houses, Crushing & screening building, ground hoppers as per the flow diagram and drawings enclosed including Area repair shop, Sub store etc. with all facilities including Toilets as detailed in the specification.
f) Internal roads with drains.
g) Fire fighting facilities and Dust Extraction/ suppression System and various pump houses required due to the same.

In addition to the facilities indicated above, civil works for providing electrical, instrumentation, control systems and water supply facilities, workers rest room, utility buildings etc and any other related civil works of above package as per customer tender requirement shall also be included in bidder's scope.

In addition to the above works, the followings civil works to be included in the scope

3. Construction of open storage yard of minimum size of 400M x 100M with barbad wire fencing security gate required approach of compacted ground for storage of steel etc.. roads pathways.
4. All sleepers and illumination external lighting all as per construction of covered store building of minimum size.15M x 30M x 6M height with GI sheet roof on supported on structural columns with all facilities as per NIT spec.
5. Construction office building for BHEL/ISG. Use of minimum size 24M x 12M with required partition toilets lighting, A/C, etc as per approved drawing.

## II DETAILED SCOPE OF WORK

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Ground | 1st Flr | 2nd Flr | 3rd Flr | 4th Flr | 5th Flr | Roof |
| 1 | Design engineering for the following Civil works | LOT | 1 | | | | | | | | |
| 2 | Survey, Soil investigation & fixing co-ordinates for various units as per layout | LOT | 1 | | | | | | | | |
| 3 | Leveling and grading of the entire RMH area as per flow diagram | LOT | 1 | | | | | | | | |
| 4 | **Civil Works related with Wagon tippler (15x 10) & Track hopper including shed-**<br>a)All Civil works associated with WT#1,2&3 and side arm chargers<br>b) Foundations for track hopper of required size to accommodate Wt# 1, 2 & 3<br>c) Excavation for WT and side arm charger foundation ,Etc<br>d) Foundation for WT #1,2&3 and SAC Proper.<br>e)Structural shed with roof and side sheeting<br>f) Rails Laying including all | LOT | 1 | | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | accessories for Wt #1,2&3 and SAC<br>g)Required nos of Hoppers with liners as per TS/GTS<br>h) Grating over hopper<br>i) Control pulpit for Wagon tippler and side arm charger approx 5M (L)x5M(W)<br>j) Civil foundation for BFA and BFB<br>k)Civil foundation for EOT crane and structural works. | | | | | | | | | | |
| 5 | Iron scraps mixed cement concrete counter weight ( Ballast) 55Ton , approx for wagon tippler - supply & casting and Construction of other misc units like gravity take ups, pits, trenches, paved areas. | LOT | 1 | | | | | | | | |
| 6 | **Single and Double Conveyor Tunnel Length 357M**<br>Conveyor Tunnel from WT to Pent Houses.<br>a) Excavation/ tunnel boring (if excavation is not feasible)<br>b) Construction of tunnel up to pent houses | LOT | 1 | | | | | | | | |
| 7 | Laying of railway track | LOT | 1 | | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| 8 | Construction of Pent houses. | LOT | 1 | | | | | | | | |
| | **Foundations and RCC floors at different level of Junction houses (74 nos) including RCC roof with roof drainage** | | | | | | | | | | |
| 9 | JH - 1 | LOT | 1 | 15 x 13 x 19.5 | 0 | +7.0 | +10.5 | +13.5 | - | - | +19.5 |
| 10 | JH - 2 | LOT | 1 | 8 x 6 x 19.5 | 0 | +6.5 | +10.5 | +13.5 | - | - | +19.5 |
| 11 | JH - 3 | LOT | 1 | 12 x 8 x 19.5 | 0 | - | - | - | | - | +19.5 |
| 12 | JH - 4 | LOT | 1 | 14 x 13 x 12.7 | 0 | +3.2 | +6.7 | - | - | - | +12.7 |
| 13 | JH - 5 | LOT | 1 | 14 x 12 x 13.5 | 0 | +4.0 | +11.0 | - | - | - | +13.5 |
| 14 | JH - 6 | LOT | 1 | 14 x 12 x 13.5 | 0 | +4.0 | +11.0 | - | - | - | +13.5 |
| 15 | JH - 7 | LOT | 1 | 14 x 12 x 13.5 | 0 | +4.0 | +11.0 | - | - | - | +13.5 |
| 16 | JH - 8 | LOT | 1 | 14 x 8 x 9.5 | 0 | +3.5 | - | - | - | - | +9.5 |
| 17 | JH - 9 | LOT | 1 | 16 x 8 x 21.5 | 0 | +7.0 | +10.5 | +14.0 | - | - | +21.5 |
| 18 | JH - 10 | LOT | 1 | 16 x 8 x 21.5 | 0 | +8.0 | +10.5 | +14.0 | - | - | +21.5 |
| 19 | JH - 11 | LOT | 1 | 16 x 8 x 21.5 | 0 | +9.0 | +10.5 | +14.0 | - | - | +21.5 |
| 20 | JH - 12 | LOT | 1 | 16 x 8 x 21.5 | 0 | +10.0 | +10.5 | +14.0 | - | - | +21.5 |
| 21 | JH - 13 | LOT | 1 | 12 x 10 x 13.50 | 0 | +4.0 | +7.5 | - | - | - | +13.5 |
| 22 | JH - 14 | LOT | 1 | 12 x 8 x 13.50 | 0 | +4.0 | +7.5 | - | - | - | +13.5 |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | JH - 15 | LOT | 1 | 12 x 8 x 13.50 | 0 | +4.0 | +7.5 | - | - | - | +13.5 |
| 24 | JH - 16 | LOT | 1 | 12 x 8 x 9.50 | 0 | +3.5 | - | - | - | - | +9.5 |
| 25 | JH - 17 | LOT | 1 | 8 x 8 x 20 | 0 | +7.0 | +10.5 | +14.0 | - | - | +20.0 |
| 26 | JH - 18 | LOT | 1 | 8 x 8 x 20 | 0 | +7.0 | +10.5 | +14.0 | - | - | +20.0 |
| 27 | JH - 19 | LOT | 1 | 8 x 8 x 20 | 0 | +7.0 | +10.5 | +14.0 | - | - | +20.0 |
| 28 | JH - 20 | LOT | 1 | 12 x 11 x 20.50 | 0 | +7.0 | +11.0 | +14.5 | - | - | +20.5 |
| 29 | JH - 21 | LOT | 1 | 15 x 17 x 23 | 0 | +8.5 | +17.0 | | - | - | +23.0 |
| 30 | JH - 22 | LOT | 1 | 12 x 8 x 14.5 | 0 | +8.5 | - | - | - | - | +14.5 |
| 31 | JH - 23 | LOT | 1 | 8 x 8 x 13.5 | 0 | +3.5 | +7.5 | - | - | - | +13.5 |
| 32 | JH - 24 | LOT | 1 | 15 x 15 x 16 | 0 | +10 | +4 | - | - | - | +16 |
| 33 | JH - 25 | LOT | 1 | 8 x 8 x 13.5 | 0 | +3.5 | +7.5 | - | - | - | +13.5 |
| 34 | JH - 26 | LOT | 1 | 65.5 x 15 x 28 | 0 | +22.5 | +0.0 | - | - | - | +28 |
| 35 | JH - 27 | LOT | 1 | 8 x 8 x 14 | 0 | +3 | +8 | - | - | - | +13 |
| 36 | JH - 28 | LOT | 1 | 8 x 8 x 11 | 0 | +5.0 | - | - | - | - | +11.0 |
| 37 | JH - 29 | LOT | 1 | 15 x 8 x 11 | 0 | +5.0 | - | - | - | - | +11.0 |
| 38 | JH - 30 | LOT | 1 | 15 x 8 x 11 | 0 | +5.0 | - | - | - | - | +11.0 |
| 39 | JH - 31 | LOT | 1 | 15 x 12 x 20 | 0 | +12 | +15 | - | - | - | +20 |
| 40 | JH - 32 | LOT | 1 | 16 x 30 x 20 | 0 | +7.0 | +14.0 | - | - | - | +20.0 |
| 41 | JH - 33 | LOT | 1 | 15 x 30 x 25 | 0 | +13.0 | +19.0 | - | - | - | +25.0 |
| 42 | JH- 34 | LOT | 1 | 67.5 x 20 x 32 | 0 | +1.5 | +12.5 | +26.0 | - | - | +32.0 |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | JH- 35 | LOT | 1 | 15 x 15 x 16 | 0 | + 6.0 | +10.0 | - | - | - | +16.0 |
| 44 | JH- 36 | LOT | 1 | 8 x 5 x 20 | 0 | +10 | +14 | - | - | - | +20.0 |
| 45 | JH- 37 | LOT | 1 | 8 x 8 x 11 | 0 | +5 | - | - | - | - | +11 |
| 46 | JH- 38 | LOT | 1 | 8 x 15 x 11 | 0 | +5 | - | - | - | - | +11 |
| 47 | JH- 39 | LOT | 1 | 8 x 5 x 15 | 0 | +1.5 | +9.0 | - | - | - | +15.0 |
| 48 | JH- 40 | LOT | 1 | 10 x 10 x 15 | 0 | +5.0 | +9.0 | - | - | - | +15.0 |
| 49 | JH- 41 | LOT | 1 | 15 x 10 x 20 | 0 | +10.0 | +14.0 | - | - | - | +20.0 |
| 50 | JH- 42 | LOT | 1 | 12 x 12 x 28 | 0 | +18.0 | +22.0 | - | - | - | +22.0 |
| 51 | JH- 43 | LOT | 1 | 15 x 10 x 28 | 0 | +18.0 | +22.0 | - | - | - | +28.0 |
| 52 | JH- 44 | LOT | 1 | 30 X 18 x 41 | 0 | +4.5 | +8.5 | +28.5 | +32.0 | +35.5 | +41.0 |
| 53 | JH- 45 | LOT | 1 | 8 X 8 X 20 | 0 | +5 | +10.0 | +14.0 | - | - | +20.0 |
| 54 | JH- 46 | LOT | 1 | 8 X 15 X 13 | 0 | +4 | +7 | - | - | - | +13 |
| 55 | JH- 47 | LOT | 1 | 8 x 8 x 31 | 0 | +20.0 | +25.0 | - | - | - | +31.0 |
| 56 | JH- 48 | LOT | 1 | 10 X 8 X 28 | 0 | +18.0 | +22.5 | - | - | - | +28.0 |
| 57 | JH- 49 | LOT | 1 | 15 x 10 x 23 | 0 | +4.5 | +17.0 | - | - | - | +23.0 |
| 58 | JH- 50 | LOT | 1 | 37.5 X 10.0 X 29.0 | 0 | +11.0 | +18.0 | +22.0 | +25.4 | | 29.0 |
| 59 | JH- 51 | LOT | 1 | 10 x 10 x 14 | 0 | +5.0 | +8.0 | - | - | - | +14.0 |
| 60 | JH- 52 | LOT | 1 | 13 X 15 X 28 | 0 | +3.5 | +18.5 | +22.0 | | | +28.0 |
| 61 | JH- 53 | LOT | 1 | 35.5 x 27.6 x 19.75 | 0 | +5.75 | +10.75 | +14.25 | - | - | +19.75 |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 62 | JH- 54 | LOT | 1 | 8 x 8 x 15 | 0 | +6.0 | +9.0 | - | - | - | +15.0 |
| 63 | JH- 55 | LOT | 1 | 7.50 x 7.50 x 26.5 | 0 | +3.5 | +20.5 | - | - | - | +26.5 |
| 64 | JH- 56 | LOT | 1 | 8 x 5 x 10 | 0 | +4.5 | - | - | - | - | +10.0 |
| 65 | JH- 57 | LOT | 1 | 15 x 12 x 30 | 0 | +20.0 | +24.0 | - | - | - | +30.0 |
| 66 | JH- 58 | LOT | 1 | 8 x 8 x 30 | 0 | +16.0 | +24.0 | - | - | - | +30.0 |
| 67 | JH- 59 | LOT | 1 | 30 x 8 x 32 | 0 | +4.6 | +26.0 | - | - | - | +32.0 |
| 68 | JH- 60 | LOT | 1 | 10 x 10 x11 | 0 | +1.5 | +5.0 | - | - | - | +11.0 |
| 69 | JH- 61 | LOT | 1 | 15 x 15 x 31 | 0 | +19.0 | +25.0 | - | - | - | +31.0 |
| 70 | JH- 62 | LOT | 1 | 8 x 8 x 16 | 0 | + 10.0 | +14.0 | - | - | - | +16.0 |
| 71 | JH- 63 | LOT | 1 | 4 x 2.5 x 16 | 0 | +6.0 | +10.0 | - | - | - | +16.0 |
| 72 | JH- 65 | LOT | 1 | 18 x 9 x 44 | 0 | +5.0 | +9.0 | +31.0 | +34.5 | +38.5 | +44.0 |
| 73 | JH- 66 | LOT | 1 | 55 x 21.50 x 15 | 0 | +40.5 | +44.0 | - | - | - | +49.0 |
| 74 | JH- 67 | LOT | 1 | 34.5 X 15 X 23.5 | 0 | - | - | - | - | - | +23.5 |
| 75 | JH- 68 | LOT | 1 | 15 x 15 x 28 | 0 | +3.5 | +18.5 | +22 | - | - | +28 |
| 76 | JH- 69 | LOT | 1 | 8 X 8 X 14 | 0 | +5 | +8 | | | | 14 |
| 77 | JH- 70 | LOT | 1 | 19 X 14 X 22 | 0 | +4 | +6.5 | +10.5 | +16.5 | - | +22 |
| 78 | JH- 71 | LOT | 1 | 15 X 10 X | | | | | | | |
| 79 | JH- 72 | LOT | 1 | 10 X 10 X | | | | | | | |
| 80 | JH- 73 | LOT | 1 | 15 X 15 X 51 | 0 | +42 | +45 | | | | 51 |
| 81 | JH- 74 | LOT | 1 | 15 X 10 X 28 | 0 | +19 | +22 | - | - | | 28 |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Foundation of conveyor galleries Trestles-** | | 1 | **(In level,Out level,Len** | | | | | | | |
| 82 | J1C1/C2 | LOT | 1 | +13.5, -15.0, 275.95 | | | | | | | |
| 83 | J1C3 | LOT | 1 | +13.5, +6.5, 83.0 | | | | | | | |
| 84 | J2C1 | LOT | 1 | +13.5, -12.0, 316.5 | | | | | | | |
| 85 | J3C1/C2 | LOT | 1 | -15, +13.5, 357.0 | | | | | | | |
| 86 | J4C1/C2/C3 | LOT | 1 | +7.0,+6.7, 223.0 | | | | | | | |
| 87 | J5C1/C2/C3 | LOT | 1 | +7.5,+3.2, 72.5 | | | | | | | |
| 88 | J6C1/C2/C3 | LOT | 1 | +11.0, 0.0, 53.5 | | | | | | | |
| 89 | J7C1/C2/C3 | LOT | 1 | +11.0, 0.0,53.0 | | | | | | | |
| 90 | J8C1/C2/C3 | LOT | 1 | +3.5, 0.0, 49.0 | | | | | | | |
| 91 | J9C1 | LOT | 1 | +14.0, 0.0, 527.5 | | | | | | | |
| 92 | J10C1 | LOT | 1 | +14.0, 0.0, 527.5 | | | | | | | |
| 93 | J11C1 | LOT | 1 | +14.0, 0.0, 527.5 | | | | | | | |
| 94 | J12C1 | LOT | 1 | +14.0, 0.0, 527.5 | | | | | | | |
| 95 | J13C1/C2 | LOT | 1 | +6.5, +7.5, 130 | | | | | | | |
| 96 | J14C1/C2 | LOT | 1 | +4.0,+7.0, 56 | | | | | | | |
| 97 | J15C1/C2/C3 | LOT | 1 | +0, +7.0, 88.5 | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 98 | J16C1/C2/C3 | LOT | 1 | +0,+3.5, 41.5 | | | | | | | |
| 99 | J17C1 | LOT | 1 | +0, +14.5, 105 | | | | | | | |
| 100 | J71C1 | LOT | 1 | +0.0, +0.0, 55 | | | | | | | |
| 101 | J18C1 | LOT | 1 | +0.0, +14.5, 105 | | | | | | | |
| 102 | J18C1 | LOT | 1 | +0, +0, 55 | | | | | | | |
| 103 | J19C1 | LOT | 1 | +0, +14.5, 105 | | | | | | | |
| 104 | J19C1 | LOT | 1 | +0.0,+ 0.0, 55 | | | | | | | |
| 105 | J20C1/C2 | LOT | 1 | +7.0, +14.5,, 372 | | | | | | | |
| 106 | J21C1/ C2 | LOT | 1 | +17, 8.5, 225 | | | | | | | |
| 107 | J22C1/C2 | LOT | 1 | +8.5, 8.5, 20 | | | | | | | |
| 108 | J23C1 (between J20 and J23) | LOT | 1 | +7.0, +7.0, 321 | | | | | | | |
| 109 | J25C1 (between J23 and J25) | LOT | 1 | +3.5, +7.0, 92 | | | | | | | |
| 110 | J26C1 | LOT | 1 | +4, +22, 90 | | | | | | | |
| 111 | J27C1 | LOT | 1 | +0.0, +8, 290 | | | | | | | |
| 112 | J28C1(130 mtr steel gallery, 70mtr ground pedestal and 300mtr with stacker reclaimer RCC foundation | LOT | 1 | +8.5, 0.00, 490 | | | | | | | |
| 113 | J29C1(130 mtr steel gallery, 70mtr ground pedestal and 300mtr with stacker reclaimer RCC foundation | LOT | 1 | +8.5, 0.00, 500 | | | | | | | |
| 114 | J30C1(50 mtr steel gallery and 300mtr with stacker reclaimer RCC | LOT | 1 | +0.0, +5, 350 | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | foundation | | | | | | | | | | |
| 115 | J31C1 | LOT | 1 | +14.0,- , 80.0 | | | | | | | |
| 116 | J32C1/C2/C3 | LOT | 1 | +14.0, +7.0, 500.0 | | | | | | | |
| 117 | J32C4 | LOT | 1 | +9, 0.0, 125.0 | | | | | | | |
| 118 | J33C1/C2 | LOT | 1 | +13.0,+7.0, 60.0 | | | | | | | |
| 119 | J33C3 | LOT | 1 | +3.5, +13.5, 367 | | | | | | | |
| 120 | J33C4 | LOT | 1 | +9, +0.0, 125.0 | | | | | | | |
| 121 | J34C1 | LOT | 1 | +26.0,+9.0, 135.0 | | | | | | | |
| 122 | J34C2 | LOT | 1 | +26.0,+1.8, 75.0 | | | | | | | |
| 123 | J34C3 | LOT | 1 | +26.0,+ 1.5, 200.0 | | | | | | | |
| 124 | J34C4 | LOT | 1 | +26.0,+20, 60.0 | | | | | | | |
| 125 | J34C5 | LOT | 1 | +26.0, +10.0, 75.0 | | | | | | | |
| 126 | J35C1/C2 | LOT | 1 | +10.0,1.5, 50.0 | | | | | | | |
| 127 | J36C1 | LOT | 1 | +14.0, +9.0, 50.0 | | | | | | | |
| 128 | J37C1 | LOT | 1 | +8.0, 0.0, 500.0 | | | | | | | |
| 129 | J38C1 | LOT | 1 | +8.0,0.0, 501.0 | | | | | | | |
| 130 | J38C2 | LOT | 1 | ** | | | | | | | |
| 131 | J39C1 | LOT | 1 | ** | | | | | | | |
| 132 | J40C1 | LOT | 1 | +9.0,+1.5, 80.0 | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 133 | J40C2 | LOT | 1 | +9.0, +6.0, 80.0 | | | | | | | |
| 134 | J41C1 | LOT | 1 | +22.0,+0.0, 65.0 | | | | | | | |
| 135 | J42C1 | LOT | 1 | +22.0,+1.5, 300.0 | | | | | | | |
| 136 | J42C2 | LOT | 1 | +22.0, 0.0, | | | | | | | |
| 137 | J43C1 | LOT | 1 | +22.0,+4.5, 150.0 | | | | | | | |
| 138 | J44C1/C2 | LOT | 1 | +13, 35.5, 200 | | | | | | | |
| 139 | J45C1 | LOT | 1 | +22.0,0.0, 80.0 | | | | | | | |
| 140 | J46C1 | LOT | 1 | +5, +7, 50 | | | | | | | |
| 141 | J47C1 | LOT | 1 | +25.0,<br>-10.0, 320.0 | | | | | | | |
| 142 | J48C1/C2 | LOT | 1 | +22.0,0.0,300.0 | | | | | | | |
| 143 | J49C1/C2 | LOT | 1 | +17.0,4.5, 125.0 | | | | | | | |
| 144 | J50C1 | LOT | 1 | +22.0,+5.0, 125.0 | | | | | | | |
| 145 | J50C2 | LOT | 1 | +17.0,4.5, 125.0 | | | | | | | |
| 146 | J51C1 | LOT | 1 | +8.0,+1.5, 80.0 | | | | | | | |
| 147 | J52C1 | LOT | 1 | +22.0,+18.0, 100.0 | | | | | | | |
| 148 | J52C2 | LOT | 1 | +22.0,+19.0, 550.0 | | | | | | | |
| 149 | J53C1/C2 | LOT | 1 | +14.25,+1.5170.0 | | | | | | | |
| 150 | J54C1/C2 | LOT | 1 | +4.0,+1.5, 20.0 | | | | | | | |
| 151 | J55C1 | LOT | 1 | +20.5,+1.5,180.0 | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 152 | J56C1 | LOT | 1 | +3.5, +4.5, 40 | | | | | | | |
| 153 | J57C1 | LOT | 1 | +13.0,+13.0,350.0 | | | | | | | |
| 154 | J58C1 | LOT | 1 | +20.0,13.0, 170.0 | | | | | | | |
| 155 | J59C1 | LOT | 1 | +26.0,16.0,375.0 | | | | | | | |
| 156 | J59C2 | LOT | 1 | +0.0, +26, | | | | | | | |
| 157 | J60C1 | LOT | 1 | +5.0,+1.5 116.0 | | | | | | | |
| 158 | J60C2 | LOT | 1 | +5.0,0.0, 90.0 | | | | | | | |
| 159 | J61C1 | LOT | 1 | +25.0,+1.5,375.0 | | | | | | | |
| 160 | J62C1 | LOT | 1 | ** | | | | | | | |
| 161 | J63C1 | LOT | 1 | +10.0,+10.0,140.0 | | | | | | | |
| 162 | J65C1/C2 | LOT | 1 | +7.0, +38.0,80 | | | | | | | |
| 163 | J66C1 | LOT | 1 | +31.0, +44.0, 165 | | | | | | | |
| 164 | J66C2 | LOT | 1 | 0, +44.0, 165 | | | | | | | |
| 165 | J67C1/C2 | LOT | 1 | +0, +18.0, 100 | | | | | | | |
| 166 | J68C1 | LOT | 1 | +8.5, +22, 185 | | | | | | | |
| 167 | J69C1 | LOT | 1 | +3.5, +5, 40 | | | | | | | |
| 168 | J70C1/ C2 | LOT | 1 | ** | | | | | | | |
| 169 | J71C1 | LOT | 1 | +10.0,+5.0, 350 | | | | | | | |
| 170 | J72C1 | LOT | 1 | +10.0,+5.0, 350 | | | | | | | |
| 171 | J73C1 | LOT | 1 | +19, +45, 310 | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 172 | J73C2 | LOT | 1 | +3, +45, 280 | | | | | | | |
| 173 | J73C3 | LOT | 1 | +5, +45, 350 | | | | | | | |
| 174 | J73C4 | LOT | 1 | +5, +45, 330 | | | | | | | |
| 175 | J74C1 | LOT | 1 | +5, +22, 600 | | | | | | | |
| 176 | SMYC1 | LOT | 1 | +10.0,+10.0, 100.0 | | | | | | | |
| 177 | RCC floor precast for conveyor gallery and walkway | LOT | 1 | | | | | | | | |
| 178 | Foundation for stacker reclaimer including drainage | LOT | 1 | | | | | | | | |
| 179 | Foundation for Slew stacker including drainage | LOT | 1 | | | | | | | | |
| 180 | Foundation for Barrel reclaimer including drainage | LOT | 1 | | | | | | | | |
| 181 | Transfer car foundations including drainage (1no) | LOT | 1 | | | | | | | | |
| 182 | Bed for stock piles at Ore Handling yard area including drainage, fire hydrant supports | LOT | 1 | | | | | | | | |
| 183 | Bed for stock piles at Coal Handling yard area including drainage, fire hydrant supports | LOT | 1 | | | | | | | | |
| 184 | MCC room for WT1,2,3 Approx size: 16M x 11M x 4M ECR for WT#1,2&3 | LOT | 1 | | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 185 | Air compressor house of size 10m x 5m ( 2 storied building ) near Wt#1, 2&3 for dust suppression system | LOT | 1 | | | | | | | | |
| 186 | Electrical sub-station room of size 19 m (L) x 13 m (W) x 21 m (H) including transformer foundations | LOT | 1 | | | | | | | | |
| 187 | ECR rooms 15M (L) x 6M (W) x 5.5M (H) | LOT | 1 | | | | | | | | |
| 188 | Construction of common fire water cum service water pump house, static under- ground water tanks(11M(L)x11M(W) x 5M(D)approx and associated civil, structural works | LOT | 1 | | | | | | | | |
| 189 | Electrical MCC Rooms for Pump house (10M x 7M) with false ceiling | LOT | 1 | | | | | | | | |
| 190 | Dispatcher cum control room 15M (L) x 10M (W) x 5M (H) including Conference room with false ceiling | LOT | 1 | | | | | | | | |
| 191 | Dispatcher-D1-CHP (15 X 10 X 5) | LOT | 1 | | | | | | | | |
| 192 | Dispatcher-D2-For coke (12 x 10 x 5) | LOT | 1 | | | | | | | | |
| 193 | Dispatcher-D3-BMP (12 x 10 x 5) | LOT | 1 | | | | | | | | |
| 194 | Dispatcher-D4-OFH (12 x 10 x 5) | LOT | 1 | | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 195 | Dispatcher-D5-OFH (12 x 10 x 5) | LOT | 1 | | | | | | | | |
| 196 | Ares Repair Shop Size of 9 X 18 x 8 m. | LOT | 1 | | | | | | | | |
| 197 | Ares Repair Shop Size of 36 X 21 m | LOT | 1 | | | | | | | | |
| 198 | Worker's rest room size 50 sqm, min height 4M | LOT | 1 | | | | | | | | |
| 199 | sub store for electrical items with the area of 15x40x9 m. | LOT | 1 | | | | | | | | |
| 200 | Air washer room 8M X 10M | LOT | 1 | | | | | | | | |
| 201 | Dust suppression building and RCC water tanks | LOT | 1 | | | | | | | | |
| 202 | Control room for weigh bridge 10 X 5 X 4 | LOT | 1 | | | | | | | | |
| 203 | RMHS building 40 x 10 x 5m | LOT | 1 | | | | | | | | |
| 204 | CHP building 40 x 10 x 5m | LOT | 1 | | | | | | | | |
| 205 | Roads system | LOT | 1 | | | | | | | | |
| 206 | Drainage, Sewage system, etc. | LOT | 1 | | | | | | | | |
| 207 | Culvert | LOT | 1 | | | | | | | | |
| 208 | Flood Light Tower Foundations and street lighting foundations | Nos | 35 | | | | | | | | |

| Sl No | Description | Unit | Qty | Dimension | Floor Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 209 | Miscellaneous Works such as Open Temporary storage yard with fencing and covered stores, Power and construction water, Illumination, Temporary Roads and Drains. Cable bridge foundation | LOT | 1 | Open Storage : 400m x 100m<br>Covered Storage: 15m x 30m x 6m<br>Site Office: 24m x 12m | | | | | | | |
| | **TOTAL** | | | | | | | | | | |

- **** To be furnished Later.**

**SPECIFICATION FOR CIVIL WORKS:**

The customer technical specification shall be followed and wherever customer specification has not been covered, BHEL technical specification to be followed as given in the following annexures.

Annexure-1 Standard Technical Specifications for GENERAL CIVIL WORKS
Annexure-2 Standard Technical Specifications for EARTH WORK
Annexure-3 Standard Technical Specifications for ROADS, DRAINS & CULVERTS
Annexure-4 Standard Technical Specifications for DRAINAGE, SANITATION & WATER SUPPLY
Annexure-5 Standard Technical Specifications for CAST-IN-SITU RCC PILES
Annexure-6 Standard Technical Specifications for CONCRETE AND ALLIED WORKS
Annexure-7 SIS CODES & REFERENCES
Annexure-8 Design, Engineering of Civil Works
Annexure-9 DETAIL SPECIFICATION FOR SILOS

**SPECIFIC REQUIREMENT:**

The contractor shall be responsible for safety of human and equipment during working. It will be the responsibility of the contractor to co-ordinate and obtain, all statutory clearances for execution of work from respective authority. The contractor shall also coordinate with other agencies like Engineering / Supervision consultant, Erection and Commissioning contractor etc at site for smooth and speedy completion of work.

**Apart from above, this contract shall be further governed by BHEL'S SPECIAL CONDITIONS OF CONTRACT (SCC) AND GENERAL CONDITIONS OF CONTRACT (GCC) enclosed with this enquiry.**

**LIST OF OTHER TENDER DOCUMENTS :**

1. Notice Inviting Tender (NIT)
2. MOU Draft
3. Integrity Pact
4. General Conditions of Contract (GCC) (BHEL)
5. Special Conditions of Contract (SCC) (BHEL)
6. HSE Manual (BHEL)
7. Technical Specification (NMDC)
8. General Technical Specification (NMDC)
9. Standard Bid Document (SBD) (NMDC)
10. Tender Drawings (NMDC)

**Annexure – 1**
**STANDARD TECHNICAL SPECIFICATIONS FOR GENERAL CIVIL WORKS**

CONTENTS :



## 1.0 BRICK MASONRY

### 1.01 Scope

The Contractor shall furnish all labour, materials and equipment required for the construction for all brick masonry work required for the construction as per drawings. The bricks shall be clay bricks or fly ash bricks as specified on the drawings and directed by Engineer.

### 1.02 Materials

#### 1.02.1 Clay Bricks

Locally available best quality bricks conforming to IS:1077 shall be used. The bricks shall be of uniform colour, strength and size with minimum crushing strength of 50 kg/cm$^2$. The bricks shall have smooth surfaces with corners straight; they shall not be twisted or chipped; when broken they shall reveal a fine, uniform, non-vitreous grain; they shall emit ringing sound when tapped with a hammer; they shall absorb water on immersion (not more than one-sixth of its original weight after soaking for 15 minutes) and dry sufficiently quickly. The bricks shall not show any sign of efflorescence after soaking and drying in shade. If the bricks show any sort of efflorescence the Contractor shall do the necessary treatment at his own cost to the satisfaction of the Engineer.

All bricks shall be subjected to inspection and approval and representative samples shall be submitted before ordering out. The bricks supplied shall conform to approved samples and may be subjected to tests as required by the engineer. Any lot of bricks found not upto the specification, must be removed from the site immediately at contractors cost. Representative samples of bricks to be used shall be submitted to the Engineer and his approval taken before bulk purchase.

The samples shall be kept sealed with the Engineer for future reference and comparison. All bricks supplied shall confirm to these approved samples in all respects. Bricks shall be carefully and systematically stacked at locations as directed in an approved manner. Each stack shall contain equal number of bricks preferably not more than 3,000.

1.02.2 **Fly Ash Bricks**

Fly Ash Brick work shall be conform to the requirement of IS: 13757. The bricks shall be regular in shape with sharp and square sides and edges and parallel faced. They shall be sound, hard of uniform composition and fully satisfy the requirements of IS : 13757. They shall not absorb water more than 20% of their own dry weight when soaked in water. Minimum crushing strength should be as per I.S. but in no case less than 75 Kg/cm2.

1.02.3 **Water**

Water shall be clean and free from deleterious matter such as oil, acid, alkali, salt and vegetable growth. Quality of water shall be same as under for cement concrete work. The water used for preparing the mortar shall be clean and free from deleterious matter and in accordance with IS specifications.

1.02.4 **Cement**

Cement shall conform to IS:269, IS:455 or IS: 1489. Cement shall be stored in weather proof sheds on dry platform and protected from rain and moisture. Cement, which has set or partially set shall not be used.

1.02.5 **Sand**

Sand shall conform to IS:2116. Grade of sand when tested as per IS:2386 shall met the requirements of IS:2116. Sand shall be clean and free from dirt, clay or other impurities.

1.02.6 **Mortar**

The mortar shall conform the requirements of I.S. 1925 and be prepared by mixing cement and sand in a mixer and the proportion as specified. Mortar shall be prepared and used as per IS:2250. Only cement sand mortar shall

be used. Unless otherwise specified on drawings / given in other sections of the specifications the mortar for brickwork except for half brick or lower thickness walls shall be 1 part cement and 6 parts sand by volume. Mortar for half brick and lower thickness brick walls shall be 1 part cement and 4 parts sand by volume.

The unit of measurement for cement shall be a bag of cement weighing 50 Kg. And this shall be taken as 0.035 cu.m. Other ingredients in specified proportion shall be measured in boxes of suitable size. Sand shall be measured on the basis of its dry volume. In case of damp sand, is quantity shall be increased suitably to allow for bulkage.

Cement and Sand shall be mixed dry thoroughly on clean approved platform and water shall then be added to obtain a mortar of the consistency of a stiff paste, care being taken to add just sufficient water for the purpose.

Mortar shall be used as soon as possible after mixing and within 2 hours after the cement is mixed wet. Mortar unused for more than 2 hours shall be rejected and removed from the site of work.

## 1.03 Brick Work

### 1.03.1 Soaking of Bricks

Bricks required for masonry in cement mortar, shall be wetted to saturation point by prolonged immersion, but never by spraying. The cessation of bubbles, when the bricks are immersed in water, shall be an indication of thorough soaking of bricks. The soaked bricks shall be kept on wooden plank to avoid earth being smeared on them.

### 1.03.2 Laying

Brick work shall be laid with best skill and the greatest care and diligence, each brick shall be pressed on the layer of the specified mortar, so that this spreads all around it and fill the joints which shall never be more than 10mm nor less than 5mm wide. Mortar ingredients shall be of proper grain size to permit joints within these limits. The thickness of joints shall not in general exceed 6mm. All joints on face shall be racked 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. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately.

The whole the brick work shall be built in English Bond unless otherwise directed. No four brick courses shall rise more than 25mm above the same laid-dry. No brick bats shall be used except where required as closures. The bricks shall be thoroughly bedded on cement mortar during each layer. After every third course reinforcing steel consisting of 2 nos. of 6mm dia mild steel bars shall be provided and these shall be anchored to the structural steel as directed by the Engineer. However, the reinforcement steel shall be separately paid for at the issue rates.

The work will be done in a proper manner in the first instance only and no grouting shall be resorted to. String courses cornices and mouldings shall not generally be provided unless as shown on the drawings or as directed by the Engineer. The architectural features and treatment if required as per the drawing or as my be finalised before execution and such items whether in large or small quantities and any shape and size, shall have to be provided by the contractor at the rates in relevant items of the bill of quantities. The Contractor shall not be eligible to claim any extra rate on this account. The brick work must be laid true to lines and level with horizontal courses and vertical perpendicular faces and corners etc.

Masonry in contact with RCC columns should be joined with either chicken meshed or dowel bars to avoid appearances of cracks. Masonry in contact with structural steel including beams and columns shall be properly anchored to the steelwork as per standard practice.

The brick work shall be protected from the effect of sun and rain and curing shall be done for a period of 7 days.

The contractor shall erect necessary scaffolding and planking for efficient execution of work at all levels.

At the end of the construction, the contractor shall ensure proper plugging of all openings made for supporting the scaffoldings.

**1.03.3** Non-Load bearing Walls

Non-load bearing walls (dividing walls) shall be built of choice bricks, for both header and stretcher courses. No broken bricks or bricks with chipped corners will be accepted.

**1.03.4** Curing

Green work shall be protected from rain by suitable covering. Brick work in cement mortar shall be kept constantly moist on all the faces for a minimum period of ten (10) days. The top of masonry work shall be left flooded at the close of the day.

1.04 **Measurements**

( Applicable for "Item Rate" contracts only )

Masonry work in general shall be geometrically measured by volume. The volume of the walls shall be reduced for all voids, hollows, recesses and openings of net area more than half a square metre, without accounting for flares, that is, discounting only the volume obtained multiplying the net span of the opening in rough by the thickness of the walls or the depth of the recess; assuming that the volume of flares and splays shall cover the higher skill required in their construction. The provision, during construction of recess and holes for passage of pipes as designed and previously arranged and ordered, shall not entitle the Contractor to any compensation. The plinth level shall be taken as 0.00 level of the respective building. Half brick wall shall be measured in Square Meters.

All the measurements are to be done as per IS:1200 (relevant parts) for the items not covered above.

2.0 **PLASTERING**

2.01 **Scope**

The Contractor shall furnish all labour, materials and equipment required for plastering all the walls and ceilings required for the Civil Works for the complete construction of the Power Station as per drawings. All walls and ceiling shall be plaster finished on all visible sides.

2.02 **Materials**

2.02.1 Cement and water used for this work shall be as given in the specification for Concrete and Allied works.

2.02.2 Sand for plaster shall have the characteristics specified in IS:1542.

The sand shall not contain any harmful impurities, as specified in Clause 3.3 of IS:2116. The maximum quantities of clay, fine silt, fine dust and organic impurities in sand shall not exceed the following limits :

| | | | |
|---|---|---|---|
| A. | Clay, fine silt and fine dust (determined in accordance with IS:383 Appendix-C and also IS:2386 (Part-II) | : | Not more than three (3) percent by weight |
| B. | Organic impurities(determined | : | Below that indicated by |

| | | |
|---|---|---|
| | in accordance with IS:2386 (Part-II) | comparison with Standard Solution specified in Clause 6.2.2 of IS:2386 (Part-II) |

2.03 **Plastering Work**

2.03.1 Plastering shall be done with 1:4 cement plaster to the following finished plaster thickness : 6mm and 12mm thick on interior surfaces and 18 mm for outside surfaces. Plaster shall be applied only when walls are perfectly dry. Jutting or recessed edges shall have sharp or suitably rounded corners, as specified by the Engineer. Plaster of all kinds, either smooth or rough finished, shall never show cracks, faulty, alignment either in horizontal or vertical planes, detachment from walls, blisters or other faults and shall have a uniform and perfectly smooth appearance. However, the new plaster shall not be trowelled to a glazed surface since white wash would not adhere to it.

2.03.2 Any faulty plastering shall in any event be removed and replaced at the Contractor's expense at the sole discretion of the Engineer.

2.03.3 The joints of brick work and masonry shall be raked out 10 mm deep with mortar still green to form key for the cement plaster and surfaces to be plastered, if not sufficiently rough, shall be thoroughly picked and roughened to provide a good bond for the plaster. The rates for plastering shall be inclusive of preparing the surface as above.

2.03.4 Cement and sand shall be mixed dry and then just enough water added to form an easily workable paste. In no case shall mortar which has been allowed to stand more than twenty (20) minutes after mixing, be used.

2.03.5 The surface of brick work, stone, concrete and other structures to be plastered shall be thoroughly cleaned from dust, dirt, oil, salt and bituminous spots, wetted, as directed before the application of the rendering coat.

2.03.6 All scaffolding log holes shall be properly filled in advance of plastering as scaffolding is being taken down.

2.03.7 For any increase in plaster thickness due to irregularities in brick work face, Contractor will not be entitled for any extra payment.

2.03.8 Proper precaution shall be taken to see that each coat of plaster is cured for a maximum period of seven (7) days by an approved method. Curing shall be done as soon as the applied plaster has hardened enough so as not to be damaged. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period can therefore be watched.

2.03.9 The Contractor shall take every precaution, right from the commencement of plaster work to prevent any defects that may appear on the surface of the plasters, and shall be responsible to make good any portion of the work which in the opinion of the Engineer requires removal and/or re-doing.

2.03.10 The uneven face plastering 20 mm thick shall be applied in two layers. The first coat 12 mm thick with the second coat 8 mm thick applied after the under coat has sufficient set but not dried and in any case within 48 hours. The plaster of under coat when brought to a true surface with a wooden straight edge, the surface shall be left rough and furrowed 2 mm deep with a scratching tool diagonally bothways to form key for the finishing coat. Facade plastering 25 mm thick shall be done in three coats with the first two coats as above and the third rough textured coat 5 mm thick of cement and black marble chips (2-3 mm size) in 1:1.5 ratio.

2.03.11 Plastering of the ceiling shall be done before wall plastering. Wall plastering shall be done from the ceiling downwards.

2.03.12 In 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 scraped cleaned and wetted with lime putty before plaster is applied to 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 near than 15 cm to any corners or arises. Horizontal joints in plaster work shall not occur on parapet tops and copings, as these invariably lead to leakage. No portion of the surface shall be left out initially to be patched up later on.

2.03.13 If directed by the Engineer the Contractor shall use approved water proofing admixture made by reputed manufacturer in the mortar for plaster work. The quantity to be used etc. shall be in accordance with the manufacturer's instructions subject however to the approval of the Engineer. These admixtures shall not contain calcium chloride unless specifically allowed by the Engineer and shall conform to IS:2645. Payment shall be made for actual quantity of such admixtures used unless it is already covered in the rates for the work concerned.

2.04 **Measurement**

( Applicable for “Item Rate” contracts only )

2.04.1 Plastering on walls and ceilings shall be measured by their actual finished surface, without taking into account jutting parts, etc. no special allowance or extra price shall be computed for these parts, nor for corners and angles. Prices are intended either for plane or curved surfaces. Provisions of transition grooved mouldings between walls and ceiling or between walls, with radius not larger than 150 mm is also included in the price, keeping in mind that plaster work shall be measured also in this case as having sharp corners.

2.04.2 All area openings, doors, windows, fan openings etc. shall be deducted while paying for plastering work. The rate quoted for plaster viz. the rate indicated in Section - E, duly increased/decreased as the case may be, by the percentage increase/decrease quoted by the tenderer and shall include finishing at bottom after completion of floors.

2.04.3 Plastering shall be measured by their actual finished surface in square metres.

## 3.0 FLOORING

### 3.01 General

The type of flooring required for the various areas shall be as indicated on the construction drawings and or as per the finishing schedule drawing and shall be provided as detailed herein:

Materials of any type and kind shall be perfect in every respect. The individual elements shall fit perfectly together and be fixed to the underlying floor without the slightly unevenness at joints; they may be of different shapes and colours and be laid as directed. Floor shall penetrate about 15 mm into the wall plaster, finished and clean, without stains and performed to best workmanship. The Contractor is fully responsible for damage resulting from abusive treatment and shall at his own expense rebuild the portions damaged. Flooring directly exposed to rain shall be cast rough/grooved to make them non-slippery. The Contractor shall submit samples of the materials to be used to Engineer for approval.

### 3.02 Grade Slab

3.02.1 The existing earth fill shall be thoroughly compacted so that there are no loose pockets left. Extra layers of earth shall be deposited to make good the settlement due to compaction of the existing fill. Each consolidated layer shall have a thickness not exceeding 200 mm and shall be consolidated to minimum 95% Proctor density at optimum moisture content. The final surface shall be evenly dressed to the specified level.

3.02.2 The bed on which the floor paving is to be laid shall be properly prepared. The sub-grade shall be cleaned of all dirt and other foreign matter. The slope desired in the floor shall be provided in the sub-grade. The ground shall be well consolidated before and after laying the sub-grade so that no settlement whatsoever takes place at a later stage. The subgrade shall be thoroughly wetted with water before laying the floor. The floor paving shall be laid in panels of uniform size in squares or rectangles not exceeding 6 square metres in area but no side shall be longer than 2.5 metres.

3.02.3 The floor paving shall be of 150 mm thick M 20 grade reinforced cement concrete and shall have 300 kg of cement per each actual cubic metre of finished vibrated concrete with sand and crushed graded stone of size not exceeding 20 mm.

3.02.4 Glass strips 40 mm wide and 3 mm thick shall be placed between the panels as directed and if considered necessary by the Engineer. The work shall be carried

out in alternate panels in the first instance so that the two (2) panels have one corner- point common. At least four (4) days shall elapse before commencing

3.02.5 Of intermediate bays. The top surfaces shall be finished to a smooth and even plane using extra cement. While being placed, the concrete shall be vigorously sliced and spread with suitable tools to prevent formation of voids or honey – comb pockets. The concrete shall be brought to specified levels by means of a heavy straight edge resting on the side forms and drawn ahead with a smooth motion, in combination with a series of lifts and drops alternating with small lateral shifts. When concreting the remaining alternate bays, care shall be taken to ensure that the edges of previously laid bays are not broken by careless or hard tamping. Immediately after laying the concrete, the surface shall be inspected for high or low spots and any needed correction shall be made up by adding or removing concret.

3.02.6 The surface shall be then finished as ordered and cured. The junctions of floors and walls, floor and dado or skirting shall be rounded off as directed without any extra payment. Any inequalities in the bed of the floor shall have to be made good by the Contractor at his own cost by providing the concrete required to provide a truly plane surface. Payment will be made only for the thickness specified. Reinforcing steel shall be paid for separately.

## 3.03 Cement Floor (IPS Flooring)

3.03.1 The cement topping shall consist of one (1) part Portland Cement, one (1) part fine aggregate and two (2) parts of coarse aggregate, proportioned by volume, with the addition of not more than eighteen (18) litres of water per bag of cement unless otherwise approved by the Engineer. The coarse aggregates shall be graded from 3 mm to 12 mm maximum size. The fine and coarse aggregates shall be free from injurious quantities of clay, loam, vegetable matter or any ingredients that may affect their bonding qualities.

3.03.2 Cement topping shall be applied in average thickness of 40 mm after all heavy construction work has been completed and all machinery, equipment units and piping have been installed.

3.03.3 All surfaces in areas to receive cement topping shall be broom cleaned and be free from loose particles; any grease, paint, oil spot, asphalt and/or tar shall be removed; any projections such as nails, bolts or screws shall be cut off flush with the concrete slab. Any laitance of scum shall be removed by the use of stiff bristle brushes.

3.03.4 Immediately prior to placing the cement topping, the base slab shall be thoroughly moistened and brush coated with a neat cement grout, to provide a mechanical bond for the surface application. The cement topping shall be placed immediately following the applied neat cement brush coat. After screeding the topping to the established grades, the surface shall be compacted by tamping and rolling, then floated with a wooden float or power floating machine.

3.03.5 After the topping has partially set the surface shall be steel trowelled to a smooth and even finish, free from tool marks. A final steel trowelling shall be given until the surfaces have set to a hard and uniform finish.

3.03.6 The top surface shall be provided with dust preventive coating as per manufacturer's specification of some approved make viz. FOSROC-lithurine or equivalent, approved by the Engineer-in-Charge.

3.03.7 Provisions for expansion joints shall be made through the entire depth of the topping at all intersections with vertical surfaces and at not more than three (3) metres intervals across the floor surface. The expansion joints shall be formed by placing 20 mm thick wooden strips and after the curing period the wooden strips shall be removed and all joints shall be filled with bitumen, asphalt or equivalent material (curing shall be done by covering with wet sacks for two (2) days and then by ponding 50 mm water for seven (7) days).

## 3.04 Heavy Duty Floor

3.04.1 Heavy duty patent stone with ironite 50mm thick or approved equal artificial stone concrete floor with hardener shall be provided for heavy equipment areas as shown on drawings or as directed by the Engineer.

3.04.2 The topping shall, if possible, be placed on the base slab before the latter has taken its final set. When this is not possible, the base slab shall be thoroughly brushed with stiff brooms, wetted for twelve (12) hours and allowed to dry before the cement concrete floor topping is laid. Surplus water shall be mopped up and a cement grout brushed well into the surface immediately before laying the screeded bed to a level 12 mm below the finishing level.

3.04.3 The cement floor shall consist of a mix of one part cement, one part sand and two parts crushed aggregate 10 mm size, as specified above, but with a slump less than 25 mm. This shall be mixed, placed, thoroughly tamped with a grill hammer and floated and screeded to receive the 12 mm thick hard topping. Hard topping shall be applied while the screeded bed is still wet. This shall consist of one part of a cement-ironite mixture to two parts by bulk of well-graded approved crushed granite of maximum 6/12 mm size. The cement ironite shall consist of well mixed dry mixture containing one part ironite to four parts cement by weight. Water shall be added after mixing the aggregate, placing, tamping, floating and trowelling being done in accordance with manufacturer's recommendations. Care shall be taken not to over trowel until the initial set has taken place.

## 3.05 Terrazo Tile Floors

3.05.1 Terrazo tiles shall be hydraulically pressed, of approved tint, pattern and size. Each tile shall be printed legibly and permanently on the back with manufacturer's trade name and ISI certification mark. The tiles shall conform to IS:1237. Face of tile shall be free from pin holes and any other such defects. The Contractor shall submit samples of the tiles for the approval of the Engineer. The tile shall be cured for a minimum period of fourteen (14) days at the shop before it being delivered to the site. The tiles shall be polished at site after being laid.

3.05.2 The underbed for horizontal surfaces shall be 20mm thick in 1:3 Cement: Sand mortar, mixed with ample water to form a stiff workable mass.

3.05.3 The tiles shall be kept wet for atleast ten (10) minutes just before laying. The under bed mortar shall be evenly spread and brought to proper grade. Before the under-bed mortar is set, cement slurry at the rate of 4.4 Kg of cement per square metre shall be applied over it. The tiles shall be immediately placed over it and pressed by wooden mallet till it reaches the desired level. The floor shall be kept moist for seven (7) days. The joints between the tiles shall be uniform and as thin as possible but not more than 1.5 mm.

3.05.4 The day after the tiles are laid all joints shall be carefully cleaned and grouted with coloured cement to match with the tint of tiles. About a week after laying of tiles each tile shall be tapped with a wooden mallet to find out if it gives a hollow sound. All such tiles and tiles broken shall be removed and replaced by new tiles till the tiles are fixed to proper line and level and polished. After the joints have developed sufficient strength, the floors shall then be properly polished to a highly glossy finish with polishing machine. After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gms per square metre sprinkled with water and rubbed hard with a pad of woolen rags. The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean. If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished. The finished floor shall not sound hollow when tapped with a wooden mallet.

3.06 **Marble Slab / Kota Stone / Marble Tile Floors**

3.06.1 The marble stone slab/tiles shall be of grade I$^{st}$ quality and of approved colour and size. The thickness of marble slab/tiles shall be 25mm thick Marble Stone / Tiles shall be provided in dado work wherever required.

3.06.2 The underbed for horizontal surfaces shall be 20mm thick in 1:3 Cement:Sand mortar, mixed with sample water to from a stiff workable mass.
The backing for vertical surfaces in dado shall be 12mm thick in 1:2 cement :sand mortar, mixed with angle water to form a stiff workable mass.

3.06.3 The marble slabs/tiles shall be kept wet for atleast fifteen (15) minutes just before laying. The water absorption capacity of marble stone slab/tiles shall not be more than 5 percent by weight. The under bed mortar shall be evenly spread and brought to proper grade. Before the under bed mortar is set, cement slurry at the rate of 4.4kg of cement per square metre shall be applied over it. The marble slabs/tiles shall be immediately placed over it and pressed by wooden mallet till it reaches the desired level. The floor shall be kept moist for seven (7) days. The joints between the tiles shall be uniform and as thin as possible but not more than 1.0mm.

3.06.4 The day after the tiles are laid all joints shall be carefully cleaned and grouted with coloured cement to match with the tint of marble slabs/tiles. About a week after laying of tiles each tile shall be tapped with a wooden mallet to find out if it gives a hollow sound. All such tiles and tiles broken shall be removed and

replaced by new tiles till the tiles are fixed to proper line and level and polished. After the joints have developed sufficient strength, The floors shall then be properly polished to a highly glossy finish with polishing machine. The floor shall be rubbed with carborandum stone and water ad then with final carborandum stone and emery powder. The surface shall then be finally smoothen down with pumic stone. After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gms. per square metre sprinkled with water and rubbed hard with a pad of woollen rags or felt. The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean. If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished. The finished floor shall not sound hollow when tapped with a wooden mallet.

3.07 **PVC Flooring**

PVC tiles flooring shall be carried out using PVC antistatic floor tiles "WONDERFLOOR' or equivalent tiles approved by the Engineer-in-Charge and conforming to IS:3462 and BS:2050. the tiles shall be 600x600mm in size and 2mm thick in approved colour. The tiles shall be laid ousting approved rubber base adhesive 'Fericol' or equivalent over cement concrete finished floor which shall be prepared with smooth surface without any pot holes, dust or dirt. While laying PVC tiles the joint shall be properly matched without any space between the tiles and tiles shall be rolled with light wooden roller weighing about 5 kg for proper adhesion to the floor surface.

3.08 **Ceramic Tiles/Glazed Tiles**

The earthenware tiles shall be of Kajaria / Nitco / Johnson make or equivalent approved by the Engineer-in-charge covered with glaze of approved size, colour and design. The tiles shall be flat and true to shape. They shall be uniform in colour, free from any flaws like cracks, chips etc. The edges and the underside of the tiles shall be free from any glaze and shall have proper indentations for proper bond. All precautions and workmanship while doing the work shall be enumerated above.

3.09 **Acid Proof Tiles**

3.09.1 Acid proofing work shall be carried out using Coromandel Prodorite Product (acid proof tiles) or approved equivalent. Over the finished R.C.C. surface apply one coat of the bituminous acid resistant paint "PRODORLAC SPL" with 230 x 115 x 38 mm thick acid resistant tiles laid over it. The tiles shall be bedded and jointed in 6 mm thick cement PRODOR SWK; the joints should be 3 mm wide.

3.10 **Curing**

Curing shall be done by covering with wet sacking for two (2) days and then by ponding with 50 mm water for seven (7) days.

3.11 **Dado**

Tiles from factory should be practically fully polished. The back of such tiles at the time of fixing to the mortar backing shall be covered with a thin layer of neat cement paste and the tile shall then be jointly tapped against the wall with a wooden mallet. This shall be done from the bottom of the surface upwards. The joint shall be as close as possible and the work shall be truly vertical and flush. After the work is set, polishing shall be done so that the surface attains a high glossy finish.

3.12 **Measurement**

( Applicable for "Item Rate" contracts only )

3.12.1 **Floors**

Floors of any kind shall be estimated on the basis of the surface area appearing between the plastered walls of the room. The keying of the floors under the plaster is therefore not included. Dado shall be paid for the surface area upto floor level. Measurement of flooring work and dado shall be in square metres to two decimal places and shall be measured by their actual surface, whatever shape or position the walls may have; skirting shall be measured in linear metres. The cost of laying shall include providing of adequate bedding/backing, filling of joints with specified mortar, all special transition pieces, groove moulds, corners all as per specification and drawings. The prices shall include cleaning and finishing of floors.

3.12.2 **Tile Facings**

Tile facings shall be measured by their actual surface, whatsoever shape or position the walls to be coated may have. The prices quoted shall include all special transition pieces, grooved moulds, corners etc.

4.0 **PAINTING**

4.01 **Scope**

The Contractor shall provide all labour, material and equipment necessary to paint, white wash, colour wash, dry distemper, plastic emulsion paint, all the items in general, including those not covered by this technical specifications. Steel doors, windows, steel rolling shutters, gangways, stairways, railing, grating, rain water pipes etc. shall be painted with synthetic enamel paint over the primer paint.

4.02 **Type of Painting**

The type of painting required for the various areas shall be generally as shown in the drawings.

4.03 **White Washing**

4.03.1 White wash shall be prepared with rich lime perfectly white, slaked by immersion.

4.03.2 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 twenty-four (24) hours and then shall be screened through a clean coarse cloth. 40 grams of gum dissolved in hot water, shall be added to each ten (10) litres of the cream. The approximate quantity of water to be added in making the cream will be 5 litres of water to one kg of lime. Indigo upto 3 gm per kg of lime, dissolved in water, shall then be added and wash stirred well. Water shall then be added at the rate of about 5 litre per kg. of lime to produce a milky solution. The surfaces specified to be white washed shall be thoroughly dried and cleaned. The white wash shall be applied by moonj brushes to the specified number of coats.

4.03.3 Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Engineer, before subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

4.03.4 Doors, windows, floors, etc. and such other parts of the building not to be white washed shall be protected from being splashed upon. Splashings and droppings, if any, shall be removed by the Contractor at his own cost and surfaces cleaned. Damages if any to fittings and fixtures shall be recoverable from the Contractor.

4.03.5 Colour wash may be applied instead of white wash by adding approved colouring agent as approved by the Engineer.

4.04 **Colour Wash**

The mineral colours not affected by lime, shall be added to white wash. Indigo shall then 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 badly applied, it shall be redone by the contractor. For new work the priming coat shall be white wash with lime or with whiting as specified in the description of the item. Two or more coats shall be applied on the entire surface till it represents a smooth and uniform finish. Before taking a room in hand sufficient colour wash shall be prepared to cover all the walls and to a uniform tint. Work in a room shall be started sufficiently early in the day to ensure the room being finished before the evening. The instructions laid down for white washing shall also apply here. Protective measures shall be as described in white washing.

4.05 **Dry Distemper**

4.05.01 Dry distemper of required colour conforming to IS:427 and of approved brand and manufacture shall be used. The primer shall be cement primer or distemper primer. The shade shall be got approved from Engineer incharge. The distemper, as required, shall be stirred slowly and mixed with clean water, preferably warm, using 0.6 litres of water per Kg of distemper or as specified by the manufacturer. Distemper shall not be mixed in larger quantities than is actually required for one days 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.

## 4.06 Oil Bound Washable Distemper

4.06.1 Oil Bound distemper of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer before application of the distemper. The distemper shall be well stirred before and during use to maintain an even consistency. Distemper shall not be mixed in larger quantity than each actually required for one day.

4.06.2 Before new work is distempered, the surfaces shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth. New plaster surfaces shall be allowed to dry for atleast six (6) months before applying distemper. The oil bound distemper shall be applied after the surface is primed with an alkali resistant primer and followed by two coats of approved oil bound distemper all as per manufacturer's specification. In the case of oil 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 pigment of relevant colour of the distemper 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 surface shall be allowed to dry thoroughly before the regular coat of distemper is applied. The next coat of oil bound distemper on completed surface shall be applied after the first coat has set for atleast 24 hours.

4.06.3 After the primer coat has dried the surface shall be lightly sand papered to make it smooth for receiving the next coat of distemper, taking care not to rub out the priming coat. The entire surface shall be coated with the mixture uniformly with proper distemper brushes (ordinary white wash brushes 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 ad 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 hung down to dry. Old brushes which are dirty or caked with distemper shall not be used. The dry distemper should be applied in dry weather only.

## 4.07 Plastic Emulsion Painting

4.07.1 Plastic emulsion paint of approved brand and manufacture shall be used. The primer where used as on new in accordance to the manufacturer's requirements shall be of the same manufacture as plastic emulsion paint and 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 for in the joint custody of the Contractor and the Engineer. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer. Only sufficient quantity of paint required for the day's work shall be prepared for new work. The surface shall be thoroughly cleaned of dust, old white or colour wash if any 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 unevenness shall be made good by applying putty made of plaster of paris mixed with water on the entire surface including filling up the undulation and sand papering the same after it is dry. The primer coat shall be applied with a brush on the clean dry and smooth surface, horizontal strokes shall be given first and vertical stroke shall be applied immediately after. This entire operation will constitute one (1) coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for atleast forty eight (48) hours, before plastic emulsion paint is applied.

4.07.2 After the primer coat has dried the surface shall be lightly sand papered to make it smooth for receiving the paint, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One (1) coat of paint properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitute one (1) coat. The subsequent coats shall be applied in the same way. Two (2) or more coats of paint shall be applied over the primer coat to obtain an even shade. A time interval of at least twenty four (24) hours shall be allowed between consecutive coats to permit the proper drying of the preceding coat. Fifteen (15) centimetres double bristled distemper brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work. Plastic emulsion paint is not recommended to be applied within six (6) months of the completion of wall plaster. Protective measures shall be as described for white washing.

## 4.08 Water-proof Cement Paint

4.08.1 Water-proof cement paint shall be of approved brand and manufacture and shall be applied on the surface to be treated in accordance with the manufacturer's specifications if so directed by Engineer. However, for guidance of Contractor the following specifications are given. The surface shall be thoroughly cleaned of all mortar dropping, dirt, dust, grease and any other foreign matter by brushing and washing. The surface shall be thoroughly wetted with clean water before the waterproof cement paint is applied.

4.08.2 Water-proof 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. Water proof cement paint shall be mixed as per the manufacturer's instructions.

4.08.3 For new work, the surface shall be treated with three (3) coats of waterproof cement paint to get a uniform shade. For old work, the treatment will be

with one or more coats as found necessary to get a uniform shade. Water 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 gypsum, wood and metal surfaces.

## 4.09 Acid Resistant Painting

4.09.1 Acid resistant paint of approved brand and manufacture shall be used. The primer where used as on new in accordance to the manufacturer's requirements shall be of the same manufacture as acid resistant paint and 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 for in the joint custody of the Contractor and the Engineer. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer. Only sufficient quantity of paint required for the day's work shall be prepared for new work. The surface shall be thoroughly cleaned of dust, old white or colour wash if any 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 unevenness shall be made good by applying putty made of plaster of Paris mixed with water on the entire surface including filling up the undulation and sand papering the same after it is dry. The primer coat shall be applied with a brush on the clean dry and smooth surface, horizontal strokes shall be given first and vertical stroke shall be applied immediately after. This entire operation will constitute one (1) coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for atleast forty eight (48) hours, before acid resistant paint is applied.

4.09.2 After the primer coat has dried the surface shall be lightly sand papered to make it smooth for receiving the paint, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One (1) coat of paint properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitute one (1) coat. The subsequent coats shall be applied in the same way. Two (2) or more coats of paint shall be applied over the primer coat to obtain an even shade. A time interval of at least twenty four (24) hours shall be allowed between consecutive coats to permit the proper drying of the preceding coat. Fifteen (15) centimetres double bristled distemper brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work. Protective measures shall be as described for white washing.

## 4.10 Chlorinated Rubber Based Paint

4.10.1 Chlorinated rubber is the product obtained from the reaction of chlorine with rubber. The product contains an average chlorine content of about 65 %.

4.10.2 Chlorinated rubber shall be formulated with resins ( for adhesion and gloss ), plasticisers, ( for flexibility and toughness ),pigments (for colour ) stabilisers and solvents ( for fluidity ). This shall meet the general requirements of IS:13467 and BS:5493.

4.11 **Preparation Of Surface**

Before starting the work the contractor shall obtain the approval of the Engineer regarding the soundness and readiness of the surface to be painted on.

4.11.1 **Masonary, Concrete and Plastered Surfaces**

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonary 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 resurfaced area shall be treated with minimum one coat of cement primer which should be continued to the surrounding area for a distance of minimum 100mm.

Surface with mildew, efflorescence shall be treated as below:-

a) **Mildew**

All mildewed surfaces shall be treated with an approved fungicide such as ammoniacal wash consisting of 7 gm of copper carbonate dissolved in 80 ml liquid ammonia and diluted to 1 litre with water or 2.5 per cent magnesium silico-fluoride solution and allowed to dry thoroughly before paint is applied.

b) **Efflorescence**

All efflorescence shall be removed by scrubbing the affected surface with a solution of muriatic acid in water (1:6 to 1:8) and washed fully with clear water and allowed to dry thoroughly.

4.11.2 All metal Surfaces shall be absolutely clean, dry and free from wax, grease or dried soap films. All steel and iron surfaces in addition shall be free from rust. All glavanized iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abration in shop coat shall be touched up with the same quality of paint as the original coat.

4.11.3 **Application**

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 metre square as per instruction of the Engineer and obtain his approval prior to application of finishing paints.

Proper tools and implements shall be used. Scaffoldings if used shall be independent of the surface to be painted to avoid shade differences of the

freshly repaired anchor holes. Painting shall be done by skilled labourers in a workman like manner. All materials shall be evenly applied, so as to be 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 undercoats 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 for production of good results. No painting shall be done when plastering is in progress or is drying. Application of paint which seals of surface to moisture shall be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before being sand papered or before the succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly.

In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Contractor when so directed by the Engineer, without any extra cost to Owner. All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade and as per approved samples and finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

## 4.12 General

4.12.1 All painting shall be performed, generally, in accordance with the detailed descriptions. In the selection of colours, agreement shall be made with the Engineer. All painting/finishing material (other than whitewash, colour wash etc.) shall be obtained ready mixed in sealed containers from approved manufacturers; these shall be of best quality, of approved make and having Engineer's approval.

4.12.2 Generally, iron and steel work etc. would have received its primary shop coat before delivered to site. No painting work shall be started, unless specimens and colours are submitted in advance to the Engineer for approval. Such approval of paint specimens by the Engineer does not relieve the Contractor of his full and entire liability as to the life and quality of paints. No products prepared in the field by the workmen shall be used, except for those not available in the market; in this case, however, the paints shall be prepared with the greatest care and best methods known in a sufficiently good quantity to assure uniform colouring; they shall be of a density and body such as to cover perfectly the surfaces to which they are to be applied. The Engineer

may, while work is in progress, take samples for the products employed in the different operations, in order to have them analysed and tested as deemed fit, all at the Contractor's expense.

4.12.3 The Contractor shall be responsible for evident or hidden faults which may become apparent even after work is finished, upto the time of final inspection and acceptance. The Contractor shall take into account the conditions of the surfaces to be painted (for example ageing of plasters, etc.) and adapt the preparation thereto, using any special operations which in practice may have proved necessary and which have been approved by the Engineer. All reconditioning or extra work which the Engineer may deem necessary for the removal of defects shall be at the Contractor's expenses.

4.12.4 All paints shall be of the best type used for that particular purpose, possessing the highest wear resistance, and shall be submitted for approval to the Engineer, who is entitled to demand such tests as he may deem fit. The Contractor shall give notice to the Engineer of each stage of painting that is to be performed, and obtain approval for each in special register prepared for the purpose. Painted surfaces shall appear absolutely even and free from any trace of brush marks and a good finish is required for those having pumice treatment.

4.13 **Measurement**

( Applicable for "Item Rate" contracts only )

All painting white washing, dry distempering, oil bound distempering, plastic emulsion painting, acid proof painting or Snowcem painting, etc. on walls, ceilings or synthetic enamel painting of steel structures, doors and windows frames etc. shall be measured as per relevant part of IS:1200 or C.P.W.D. Specification.

## 5.00 STEEL DOORS, WINDOWS, VENTILATORS AND ROLLING SHUTTERS

### 5.01 Scope

The contractor shall furnish all labour, material and equipment required for supply, transportation and fixing in position all the doors, windows and rolling steel shutters required for the civil works as per drawings.

### 5.02 Doors, Windows & Ventilators

All windows and door frames of any kind and size shall be made of standard steel shapes and be of the tight closing type; double contact, stiffened windows shall be partly hinged and partly fixed.

Hinges windows shall be actuated by means of special easy to adjust and operate devices, smoothly operating, all the doors shall be of standard construction, with shape and size of openings as indicated in the drawings. All standard steel doors, windows and ventilators or approved best quality shall conform to IS:1038, IS:1361 and IS:4351 unless other-wise stated.

All fittings shall be superior chrome plated quality or anodised aluminium as required. The Contractor shall submit samples or all fittings and provide only the selected/approved fittings.

Each door shall be provided with :

- One (1) superior quality rim lock or mortice lock with handles on both sides and two (2) 150 mm Tower Bolts to close the door from inside.
- One (1) approved brass door closer
- Necessary lugs for fixing

Each window shall be provided with :

- Peg-stay arms
- Handles
- Tower Bolts

Each ventilator shall be provided with :

- Bronze cup pivots and spring catch closure.

All steel doors, windows and ventilators shall be given a coating with Redoxide primer. This shall be touched up during installation as necessary. The colour coating shall match the painting schedule.

Doors shall be completely or partly sheeted with 16 gauge metal sheet.. Doors of toilets, wash rooms, etc. shall be fully sheeted with the bottom portion constructed as a louvred ventilator. Kick plates shall be provided. Two (2) keys shall be provided for each door and in addition a master and sub-master keys shall be provided, as required.

Door Frames

Frames shall be reinforced for door closers. They shall be mortised, reinforced, drilled and tapped for hinges, lock and bolt strikes. Flush butt welding to form a solid fuses joint, so that all frames are square and flat shall be sued with sections cut to required length and mitred. Rubber door silencers shall be furnished for the striking jamb. Loose “T” Masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties / weather bars installed in place.

**Double Plate Flush Door Shutters**

Door shutters shall be 45mm thick, completely flush design and shall comprise of two sheets of 18G steel sheets, rigidly connected and reinforced inside with continuous vertical 20G stiffners, spot welded in position at not more that 150mm on centres. Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally by steel channels running full width of door. Doors shall not have more than 2.5mm clearance at jambs and head shall have proper level on lock stiles and rails to operate without binding and shall be reinforced at corners to prevent sagging or twisting. Pairs or double doors shall have meeting stile edges beveled or rebated.

Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closer, push plates and other surface hardware where necessary. Any drilling and tapping required for surface hardware shall be done at site. Wherever required, provision shall be made for fixing glazing, vision panels, louvers etc. Glazing mouldings shall be of 18G mild steel or extruded aluminium sections with profiles shown in drawings and suitable for fixing 6mm glass. Louver blades shall be V or Z shaped and made out of 16G sheets.

Pressed Steel Louvers

The louvre blade shall be 'Z' shaped and made of 18 gauge sheets in EZ 7 steel frames. The frame shall be of ISMC-100 unless shown otherwise on approved drawings.

5.02.1 **Installation**

After the masonry work has been constructed the Contractor shall install the doors, windows and ventilators frames in line and plumb and shall firmly anchor these to the masonry with approved metal anchors. The Contractor shall ensure that variations in building dimensions (contractions, expansion etc.) will not cause the doors, windows or ventilators to jam or not close properly. Work not properly anchored or out of plumb shall be rectified to the Engineer's satisfaction. After all Civil works under this and other sections have been completed, the Contractor shall carefully inspect all doors, windows and ventilators and make necessary adjustments to ensure efficient operation.

5.03 **Rolling Shutters**

5.03.1 The rolling steel shutters shall be as per IS:6248, of an approved design and make. The dimensions shall be as shown on the drawings. Wicket gates shall be provided, where required.

5.03.2 In case of hand operated pull and push type rolling shutters of sizes larger than 10 sq.m. in area and in case of very large gear operated and/or as

directed by the Engineer, rolling shutters shall be provided with ball bearings for smooth and efficient operation and with the provision of wicket gate and ventilator where necessary. In case of large rolling shutters and depending upon local wind conditions, the rolling shutters should be provided with special locking type of wider channel guides or it shall be provided with central movable channel supports to take up the design wind pressures in the area.

5.03.3 **Power Operated Rolling Shutter:**

These shall be operable from a push button station conveniently located besides the door or as shown on drawings. One emergency and chain.crank operation shall also be provided for use in case of power failure or failure of electric system. Where called for in schedule, externally mounted shutters shall be operated by control mechanism located inside the building.

5.04.01 **Installation**

The shutter shall be erected complete with all necessary hardware, operation mechanisms, equipment, wiring and materials to suit the sizes of the openings. All electrical works shall be in accordance with the Indian Electricity Regulations.

5.04.02 **Tests**

After the equipment has been installed, tests shall be made by the Contractor in the presence of the Engineer to ensure efficient operation of the equipment. These tests shall be repeated after all Civil works have been completed and the Contractor shall make necessary checks and adjustment to ensure efficient operation.

5.05 **Measurement**

( Applicable for “Item Rate” contracts only )

Steel doors, windows and ventilators including fixtures shall be computed by square metres. Rolling steel shutters shall be computed by Square metres.

6.0 **ALUMINIUM DOORS, WINDOWS AND VENTILATORS**

6.01 **Scope**

The Contractor shall furnish all labour, material and equipment required for supply, transportation and fixing in position, all anodized aluminium doors, windows, ventilators, excluding glass required for the construction as per drawings.

6.02 **Doors**

The doors shall be built from extruded anodized aluminium sections. The panels shall be of anodized aluminium sheet of not less than 18 gauge thickness, unless otherwise specified. The finished work shall be plumb, in line and free from corrugation, depression or wavy appearance and any defects rectified. Field connections of all works may be made with concealed screws or approved type of fasteners or may be welded as approved by the

Engineer. Fabrication Drawings - Before starting fabrication of all metal doors, windows etc. the Contractor shall submit detailed fabrication drawings to Engineer for approval. Only after approval of drawings, the fabrication work shall be started. All fittings and fixtures shall be of matching shade inline with overall finishes.

Workmanship - Workmanship shall be of best quality, free from any flaws and defects. Approval of the Engineer shall be taken for the samples of each type of work after submitting the same, before starting the bulk manufacture.

Transporting - Packing, despatching, loading and unloading from wagons/trucks shall be done by the Contractor with all care to ensure safe arrival of materials at site in undamaged condition.

6.03 **Anodized Aluminium Louvers**

Aluminium louvers shall be of an approved design, horizontal or vertical type, designed to resist a wind pressure of 250 kg. per square metre. The louvers shall be of atleast18 SWG anodized aluminium. Extruded anodized aluminium sections shall be used for supports as required and operating devices shall be of anodized aluminium of matching shades. Approved bi- metallic corrosion protection paint shall be used where required.

6.04 **Measurement**

( Applicable for “Item Rate” contracts only )

Alluminium doors, windows, ventilators, and louvers shall be computed by square metres.

7.0 **GLAZING**

7.01 **Scope**

The Contractor shall furnish all labour, material and equipment required for supply, transportation and fixing in position, all types and sizes of glasses required for the civil works for the complete construction as per drawings.

In general wherever applicable and unless otherwise noted, work shall conform to IS:1081 (latest) `Fixing and Glazing' (steel and aluminium) doors, windows and ventilators.

7.02 **Glazing Work**

Glazing for doors, windows and ventilators (both steel and anodized aluminium) shall be of 5.5 mm thick plate glass conforming to IS:2835 flattened sheets or 6 mm thick wire reinforced glass panels of superior approved quality. Wired glass shall be rolled glass with centrally embedded 24 G wire mesh of Georgian type. This may be of clear or coloured glass, as required by Engineer and shall conform to IS:5437.

The glass shall be brought to site in the original packing from the manufacturer and cut to size at site. The cut edges shall be straight and free from chips, spall or any other damages.

All glass panes or panels shall be free from flaws, specks, bubbles and wavy surface and shall have a uniform refractive index. All panels shall have properly squared corners and straight edges. Any defective or damaged glass shall be rejected forthwith. Putty shall be fresh and ready mix of superior aproved quality conforming to IS:400 (latest).
Glass panes shall be securely fixed in position by means of putty ( as per IS:419 ), mastic paint and glazing clips. Rebates or grooves shall be oiled and cleaned before glazing. Glazing shall be commenced only after all other work in the respective portion has been completed, all glazing shall be thoroughly cleaned with turpentine to remove any stains of paint smears, spots and other blemishes. Bolts, nuts and beds as required shall be provided alongwith glazing clips. All fasteners, clips, clamps etc. shall be anodised aluminium / epoxy coated steel / double dipped glavanized matching the overall shades and finish.

Neoprene gaskets with snap-fit glazing, where required, shall be fixed as per manufacturer's instruction and shall fit firmly against the glass to give a leak proof installation.

All glass shall be thoroughly cleaned before placing in positions. Each glass pane shall be held in place by special glazing clips of approved type. As specified in relevant IS Codes, four glazing clips shall be provided per glass pane, except for large panes where six or more clips shall be used as per Engineer's instructions. All holes that may be necessary for holding the clips, glazing beads and all other attachments shall be drilled by the Contractor.

Glass pane shall be set without springing, and shall be bedded in putty and back putted, except where mouldings or gaskets are specified. Putty, mastic cement etc. shall be smoothly finished to a true even line. Obscure and figured glass shall be set with smooth side out.

After completion of glazing work, the Contractor shall remove all dirt, stains, putty etc. clean the glass panes and leave the work in perfectly acceptable condition. All broken, cracked or damaged glass shall be replaced by new ones at the Contractor's own cost.

**7.03** Acceptance Criteria

All installations shall be free from cracked, broken or damaged glass. Edges of large panes of thicker glass and heat absorbing glass shall be inspected carefully for chipped, cracked or ungrond edges.

Glazing shall be carefully done to avoid direct contact with metal frames.

All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak-proof installation.
At completion, the panes shall be free from dirt, stains, excess putty etc. and to complete satisfaction of the Engineer.

7.04 **Measurement**

( Applicable for "Item Rate" contracts only )

Glazing shall be computed by square metres of glass areas inclusive of the area occupied by putty/beading.

## 8.0 FALSE CEILING

8.01 **Scope**

The work under this sub-section shall include the supply and installation of suspended ceiling together with the suspension system as shown on drawings or specified in schedule of items with all materials, labour and equipment. The work shall also include providing of openings in the ceiling for lighting, air-conditioning diffusers, etc. as shown on drawings or as instructed by the Engineer.

8.02 **Installation**

*Suspension System*

Suspension system shall consist of grid supporting the ceiling panels intermediate runner supports for the grid if any, and hangers wall angles etc. required to suspend the grid or the runners from structural walls, slabs and beams or trusses.

All members of the suspension system shall be of sufficient strength and rigidity to carry the ceiling board or sheets in a true and level plane without exceeding a deflection of $1/500^{th}$ of their span. All joints in ceiling panels shall run straight and cross joint shall be at perfect right angle. Angle moulds shall be securely fixed to walls. All drillings of structural concrete or welding to steel for installation of the suspension system shall be included in the rate. All M.S. section, wherever used for supports etc. shall be given one coat of synthetic enamel paint over a coat of red lead primer of two coats of aluminium paints. All wood supports shall be painted with two coats of approved wood preservative before erection.

8.03 **Pre-laminated Particle Board False Ceiling**

Aluminum grid ceiling system shall consist of anodised Tee-section (runners) spaced at 600mm centers.

Angle cleats or other suitable fixing device shall be fixed to the structural beam or slab above for fixing of hanger. Runners shall be hung by MS road with a provision of levelling arrangement at a spacing of 1200 C/C. Extra hangers shall be provided at light fixtures that are supported from the ceiling system.

The cross tees shall intersect main tees in pattern shown on drawings and positively locked together with intersection clips. All perimeter areas shall have angle mouldings fixed to vertical walls surfaces and end tees shall rest on the mouldings unless otherwise shown on drawings.

40mm thick Resin bonded fibreglass wool of Density 60kg/$m^3$ faced with WMP-10 with edges covered with the same and having Fibreglass Tissue provided on the upper faced in size 600x600mm shall be placed on the grid.

8.04 **Pre-coated False Ceiling Panels**

a) **Ceiling Panels**

i) 84 mm wide x 16mm deep plain roll formed panels out of 0.5 mm thick aluminium-Magnesium Alloy (Al-Mg AA5050) stove enamelled on both sides. The maximum length of the panel shall be upto 6m and in any desired colour of dry paint thickness of approx. 15-20 microns on the main side.

ii) Panel Splice

Same as ceiling panel but 83mm wide and 150mm long.
The Engineer may approve any other type and shape permancently colour
coated Aluminum false ceiling system meeting strength, durability and other
functional requirement specified above.

**Acoustical and insulation blanket**

50mm thick resin bonded fibreglass wool of 24kg/$m^3$ density as per IS:8183 bound in black polythene shall be laid on top of the ceiling panels to provide insulation and acoustics. Minimum density of the material shall be same as specified for wall cladding. Under deck insulation shall also be provided below the ceiling of roof slab wherever required according to Air-conditioning system. Under deck insulation below the floor slab shall also be provided wherever the space below the air conditioned area is not air conditioned.

b) **Erection**

J-hooks shall be inserted into the slab or overhead structural support with the help of nylon washers. The rod Hangers of desired height shall be hung from these and clipped on the Spring Steel Clips which in turn shall be clipped onto the 0.95mm thick Aluminium-Magnesium carriers. Hangers shall be fixed approx. 1.5 meters from each other. The panels shall then be clipped onto the carriers and spliced wherever necessary.

8.05 **Grid Frame**

A separate steel grid frame shall be provided above the false ceiling level to facilitate maintenance of fittings and installations wherever shown in the drawings. ISMC75 at a spacing of 1.2m c/c shall be provided with 12mm dia hanger bar. The false ceiling system shall be suspended from this grid frame. All members shall be painted.

8.06 **Under Deck Insulation**

a.**General**

*Thermal insulation shall be provided on the ceiling of top/ or bottom slab of air conditioned areas according to the system requirements.*

b.**Material**

Insulation shall be of fibreglass of density 32kg/cum. Conforming to IS:8183. Minimum thickness of the material shall be 50mm

c. **Method of Fixing**

The fixing shall generally be with slotted MS angles 100x65x6mm fixed to the soffit of RCC roof slab at 600mm centers in both directions by raw plugs/expansion fasteners of adequate strength. However, the available insert plates, if any provided at the time of casting of RCC slab, can also be used for fixing.

50mm thick insulation material shall be made out of fiber glass Wool 2000 faced with 8-9 Micron thick aluminium foil and 24 G (0.56) x 12mm mesh wire netting. The mat shall be stretched tightly across the slotted angles or slotted plates, holding it in place by means of wires. The joints of the wire netting shall be butted and tightly laced down with 12mm (14G) dia GI wire. The insulation shall also cover the existing steel beams in that area.

9.0 **ROOF INSULATION AND WATER PROOFING**

9.01 **Scope**

The Contractor shall furnish all labour, materials and equipment required for insulation and water- proofing to be done for the Civil Works for the complete construction as per drawings.

9.02 **Foam Concrete**

The foam concrete where specified drawings shall be laid cast-in-situ to 50 mm average thickness. The insulating weight shall not exceed 480 kg. per metre cube, Thermal Conductivity of foam concrete shall be between 0.48 to 0.7 B.T.U./hr./Sq.ft/$^{o}$F. Broken and other pieces damaged in any way shall not be used. Materials shall be check-tested and approved to ensure that insulation qualities are complied by each lot. The slab base and/or insulating slabs shall be laid to necessary slope for drainage.

9.03 **Felt Membrane Water Proofing**

Construction of water-proofing shall be as follows :

1. A 12 mm thick uniform or varying 1:4 cement plaster layer on the top of the foam concrete cast in-situ after it is fully cured and dried.

2. Three (3) layers of roofing hessian based Bitumen felt, alternated with four (4) layers of hot bitumen (Blown grade bitumen 85/25 at the rate of 1.6 kg/$m^2$).

3. One (1) layer of washed pea-gravel well set in bitumen water-proofing of roofs shall be done in accordance with IS:1346.

At the parapets, opening frames of ventilators and other openings the water-proofing (and the underlay, as required) shall be turned up, tucked, bevelled and/or finished to approved or detailed designs to ensure water-proof joints, while permitting freedom of expansion. The pea gravel shall be from an approved source and shall be washed. It shall pass through 6 mm screen.

The water-proofing shall be guaranteed for twenty five (25) years. Leakage or damages occurring during this period shall be made good by the Contractor at his cost at site.

9.04 **Elastomeric Waterproofing**

9.04.1 Waterproofing of flat roof slab shall be done with “BRUSHBOND”, An elastometric joint less waterproofing membrane.

Clean all surfaces free of dust, laitance, foreign matter etc., by stiff wire brushing. Oil and grease should be cleaned using a chemical degreaser and wash with clean water and allowed to dry. Remove all high spots from concrete surface and the surface shall be roughened by slight grinding. Clean the surface with a vacuum

pump to remove fine dust. Presoak the surface by flooding water for a minimum period of 2-3 hrs. and should be completely removed prior to the application of waterproofing coating.

9.04.2 **Application of waterproofing membrane**

a. Mix Brushbond (23 kg powder + 4 kg polymer) in a metal drum with recommended quantity of water using a slow speed drill machine fitted with a paddle for about 4-5 minutes. Hand mixing should be strictly avoided.

b. Whilst the surface is damp with no traces of free water, apply the mixed Brushbond using short stiff nylon brush of 120-200 mm wide by scrubbing it well into the substrate. The Brushbond coating shall be taken continuously on the parapet wall to it is full height. Allow the first coat to dry for 6-8 hrs.

c. Apply the second coat of brushbond in right angles to the first coat and shall be allowed to dry and the third coat shall be applied in the same manner. Whilst the third coat is wet, sprinkle dry coarse sand for better adhesion of protection screed.

d. Apply the second coat of brushbond in right angles to the first coat and shall be allowed to dry and the third coat shall be applied in the same manner. Whilst the third coat is wet, sprinkle dry coarse sand for better adhesion of protection screed.

9.04.3 Protection Layers

a. Apply 15mm thick 1:3 cement sand screed as protection layers over the applied Brushbond coating. Polyester fibres shall be used to prevent cracking of the protection screed.

b. A 50 mm thick screed concrete layer shall be provided over the proof slab in required slope.

c. The top surface shall be finished by fixing brick tiles.

9.04.4 **Guarantee**

The contractor shall give a guarantee in writing in acceptable form for all works executed nder this specification supplemented by a separate and unilateral guarantee from the specialised agency for the roof water-proofing treatment work. The Contractor shall give a guarantee for materials and workmanship and satisfactorily functioning of the water-proofing treatment for a period of (6)

six years for heavy treatment and for a period of (8) eight years for extra heavy treatment in case of Bitumen felts and 15 years in case of Elastomeric membrane from the date of completion of the work or the date of handing over the site to the Engineer whichever is later. The specialist agency / Contractor shall endorse the guarantee, beyond the defect liability period as indicated, in favour of the Owner. The Contractor shall replace / rectify defects, if any, observed in the water-proofing treatment to the satisfaction of the Engineer.

9.05 **Measurement**

( Applicable for "Item Rate" contracts only )

These shall be computed on the basis of geometrical surfaces actually constructed in square metres.

9.06 **Damp Proofing**

Damp proof course shall be 40mm consisting of cement concrete in the proportion 1:2:4 (1 cement, 2 Sand, 4 Graded aggregates 10mm down) with admixture of a water proofing compound as approved by the engineer. The percentage of admixture shall be 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 surface of the brick/stone work shall be levelled and prepared before laying the cement concrete. Edges of DPC shall be straight and even. The side shuttering shall consist of wooden forms and shall be strongly and properly fixed, so that it does not get disturbed during compaction and mortar does not leak through. The concrete mix shall be of workable consistency and density. When the side shuttering are removed the surface shall come without hone-combing. The top surface shall be double chequered and cured by ponding for at least 7 days. Cement Bitumen at the rate of 1.2 kg/sqm. shall be applied over the dried surface and cement concrete properly cleaned with brushes and finally with cloth soaked in kerosene oil. The Bitumen shall be applied uniformly so that no blank spaces are left any where.

9.07 **Water Proofing Agent**

Where specified and approved by Engineer, Water Proofing Agent conforming to IS:2645, shall be added in quantities specified by Engineer.

10.00 **RAIN WATER PIPES**

10.01 Rainwater downtake pipes shall be UPVC / CI / MS pipes, as specified on drawings / elsewhere in the specifications. MS pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer. Rain water pipes shall be adequately provided to drain out the rainwater without overflow. Minimum 100mm diameter pipe shall be provided to drain out 40 Sqm. of roof surface area and minimum 150mm diameter to drain out 80 Sqm. of roof

surface area. All vertical down spout pipes and pipefittings shall run inside the walls. All vertical down spout pipes shall be connected to water proof roofing by means of lead funnels protected at the outside by a cover net of brass wire or by $90^0$ bends (elbow).

10.02 All covers for water collecting pits, both inside and outside the buildings, shall be of cast iron, with proper holes, and designed to withstand any possible transient load. Such cast iron covers shall be of commercial size and as far as possible the closest to far indoor pits minimum 250mm x 250mm and for outdoor pits 600 x 600mm.

10.03 Cast iron pipes shall be straight and perfect in every detail, of uniform thickness and with smooth internal surface free from any casting faults, and shall comply with IS:1230. Pipes to be embedded in masonry shall be fixed in the masonry work as it proceeds. Care shall be taken to keep the pipes absolutely vertical or to the lines as directed by the Engineer. Pipes shall have a surrounding of 12mm minimum thickness of mortar at every position of the external surface. The mortar shall be of the same mix as is used in the masonry. The joints shall be caulked in with lead as soon as the next length of pipe is placed in position. The open end (socket end) of the pipe shall be kept closed till the next length of pipe is fitted and jointed to prevent any brick bats or concrete or pieces of wood falling in and choking the pipe. The spigot end shall butt the shoulder of the socket and leave no gap in between. The annular space between the socket and the spigot will be first well packed in with spun yarn leaving 25mm from the lip of the socket for the lead. The joints shall then be lead caulked as described in IS:3114. Cast iron pipe fittings shall be of standard size, and shall ring clearly when struck all over with a light hand hammer. The thickness of fittings and details of spigots and sockets shall be same as those of the corresponding size of straight pipes.

## 11.00 GUTTERS

The gutters shall be made of GI aluminium (INDAL). All gutters shall be supplied by reputable specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform, GI gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated MS brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

12.00 **PLINTH PROTECTION**

All buildings shall be provided with 1000mm circle and 75 thick PLC of grade M-15 for plinth protection al-round. The plinth protection shall be laid over well-compacted soil and base formed with broken bricks on rubble compacted to a thickness of 75mm. Base shall include greeting with fine sand with approved suitable ground treatment/improvement for loose expansive soil underneath of necessary.

**13.00 APPLICABLE CODES AND SPECIFICATIONS**

The following codes, standards and specifications are made a part of this specification. All standards, tentative specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions.

13.01 **Plastering, Flooring, Painting & Finishes**

| | | |
|---|---|---|
| IS:2394 | : | Code of practice for application of lime Plaster finish |
| IS:1443 | : | Code of practice for laying and finishing of cement concrete flooring tiles. |
| IS:2114 | : | Code of practice for laying in situ terrazzo floor finish |
| IS:777 | : | Glazed earthern tiles |
| IS:427 | : | Distemper, dry, colour as required. |
| IS:2395 | : | Code of practice for painting concrete, masonry and plaster surfaces. |
| IS:1477 | : | Code of practice for painting of ferrous Metals in buildings ad allied finishes. |
| IS:2338 | : | Code of practice for finishing of wood based materials (Part-I) |
| IS:2932: | | Specification for enamel, synthetic, exterior type-I |
| IS:2933: | | Specification for enamel, synthetic, exterior type – II. |

| | | |
|---|---|---|
| IS:5410 | | Specification for cement paint, colour as required.<br><br>Specification for chlorinated rubber for paints. |

13.02 **Doors, Windows, Ventilators, Glazing**

| | | |
|---|---|---|
| IS:4021-1983 | - | Specification for timber door, window And ventilator frames. |
| IS:2202-1991(Part-I) | - | Specification for wooden flush door shutters (Solid Core Type) |
| IS:1003(Part –1&II) | - | Specification for timber panelled and glazed shutters |
| IS:4020-1992 | - | Methods of tests for wooden flush doors shutters. |
| IS:4351-1976 | - | Specification for steel door frames. |
| IS:1038-1983 | - | Specification for steel doors, windows and ventilators. |
| IS:1081-1960 | - | Code of practice for fixing and glazing of metal (Steel and Aluminimum)doors, windows and ventilators |
| IS:5807 (Part I&IV) | - | Method of test for clear finishes for Wooden Furniture. |
| IS:2835-1987 | - | Flat transparent sheet glass. |
| IS: 3548 | - | Code of practice for glazing in building |
| IS:419 | _ | Putty for use on window frames. |
| IS:6248 | _ | Specifications for metal rolling shutters and rolling grills. |

13.03 **Water Proofing, damp Proofing & Insulation**

| | | |
|---|---|---|
| IS:2645-1975 | : | Specification for Integral Cement Water Proofing Compounds. |
| IS:3384-1986 | : | Specification for bitumen primer for use In water proofing and damp proofing. |
| IS:1580-1991 | : | Bituminous compounds for water proofing and caulking purposes. |
| IS:1322-1982 | : | Specification for bitumen felts for water Proofing and damp proofing. |
| IS:1346-1991 | : | Code of practice for water proofing of roofs with bitumen felts. |
| IS:7290-1979 | : | Recommendation for use of Polyethlene film for water proofing of roofs. |
| IS:9918-1981 | : | Code of Practice for in-situ water proofing And damp proofing treatment with glass fibre tissue reinforced bitumen. |
| IS:6598-1972 | : | Cellular concrete for thermal insulation. |

14.00 **SAMPLING, TESTING AND QUALITY CONTROL**

14.01 **General**

a) The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and / or International Standards and shall conduct such tests as are called for by the Engineer. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted Engineering practice to the directions of the Engineer. Tests shall be done in the field and at a laboratory approved by the Engineer, the test results in triplicate within three days after completion of a test. The Engineer may, at his discretion, waive off some of the stipulations given below, for small and unimportant operations.

b) Material / work found unsuitable for acceptance, shall be removed and replaced by the Contractor. The works shall be redone as per specification requirements and to the satisfaction of the Engineer.

14.02 **Quality Assurance Programme**

The Contractor shall submit and finalise a detailed Field Quality Assurance Programme within 15 days from the date of award of the Contract according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus / equipment, deployment of qualified / experienced manpower, preparation of format for record, field quality plan etc. On finalised field quality plan, Owner shall identify, customer's hold points beyond which work shall not proceed without written approval from the engineer.

14.03 Frequency of sampling and testing including the methods for conducting the tests are given in the Table below. The testing shall be done at site. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. Some of the type tests and performance tests which are not included in the table shall be carried out at the manufacturers premises or at an independent Government approved laboratory.

14.04 All masonry shall be built true and plumb within the tolerances prescribed as below. Care shall be taken to keep the perpends properly aligned.

a) Deviation in verticality in total height of any wall of a building more than one storey in height shall not exceed $\pm$ 12.5 mm.

b) Deviation from vertical within a storey shall not exceed $\pm$6mm per 3m height.

c) Deviation from the position shown on the plan of any brick work more than one storey in height shall not exceed 12.5mm.

d) Relative displacement between load bearing walls in adjacent storeys intended to be in vertical alignment shall not exceed 6 mm.

e) Deviation of bed joint from horizontal in any length upto 12m shall not exceed 6mm, and in any length over 12m it shall not exceed 12.5mm total.

f) Deviation from the specified thickness of bed joints, cross-joints or perpends shall not exceed $\pm$3mm.

**TABLE**
**FREQUENCY OF SAMPLING AND TESTING**

| Sl. No. | Nature of Test / Characteristics | Method of Test | No. of samples and Frequency | Remarks |
|---|---|---|---|---|

| Sl. No. | Nature of Test / Characteristics | Method of Test | No. of samples and Frequency | Remarks |
|---|---|---|---|---|
| **A** | **Burnt clay bricks & Fly ash bricks** | | | |
| | a) Dimensions | Relevant clause of IS:1077 of burnt clay bricks and IS:12894 for fly ash lime bricks. | | Max. 8% deviation for non-modular bricks. For modular bricks as per clause no. 5.2 of IS:1077. For face bricks as per IS:2691. For fly ash lime bricks as per IS:12894. |
| | b) Compressive strength | IS:3495 (Part-I) | | As specified. |
| | c) Water absorption | IS:3495 (Part-II) | A set of 20 bricks (min) for each lot of 50,000 or part there of for all test (a to c) | Max. 20%.<br>However, 15% for face bricks only. |
| **B.** | Sand | | | |
| | a) General quality | Visual | One set of samples from each source of material per 100cum or part thereof. | As specified. |
| | b) Deleterious material | IS:2386 (Part-I & II) | One set of samples from each source of material per 100cum or part thereof. | Clause 3.3 of IS:2116 |

| Sl. No. | Nature of Test / Characteristics | Method of Test | No. of samples and Frequency | Remarks |
|---|---|---|---|---|
| | c) Grading | Sieve analysis as per IS:2386 (Part-I) | One set of samples from each source of material per 100cum or part thereof. | Table 1 of IS:2116 |
| **C.** | Cement | | | |
| | a) Setting time | IS:4031 | One set of samples for each lot of material received. | No separate testing is required in case cement is tested for preparation of concrete mix. |
| | b) Compressive strength | IS:4031 | One set of samples for each lot of material received. | No separate testing is required in case cement is tested for preparation of concrete mix. |
| **D.** | Water | | | |
| | a) Harmful sub-stances. PH value | IS:3015 | Once a month for each source | No separate testing is required in case water is tested for concrete mix. |
| | b) Initial setting time | IS:4031 | Once a month for each source | No separate testing is required in case water is tested for concrete mix. |
| | c) Compressive strength pH value | IS:516 | Once a month for each source | No separate testing is required in case water is tested for concrete mix. |
| **E.** | Mortar | | | |

| Sl. No. | Nature of Test / Characteristics | Method of Test | No. of samples and Frequency | Remarks |
|---|---|---|---|---|
| | a) Compressive strength | Appendix –A of IS:2250 | One sample (Consisting of min. 3 specimens) | Table – 1 of IS:2250 |
| | b) Consistency | Appendix – B of IS:2250 | One sample for each type of mix | Clause 7.2 of IS:2250 |
| | c) Water Retentivity | Appendix –C of IS:2250 | One sample for each type of mix. | Clause 7.3 of IS:2250 |
| **F.** | Masonry Construction | | | |
| | a) Workmanship | Visual & Physical measurement | All work | As per specification and Clause No. 11.0 of IS:2212 for brick work. |
| | b) Verticality and alignment | Physical measurement | All work | As per specification and Clause No. 6.3.4 of IS:1005. |

**Annexure-2**
**STANDARD TECHNICAL SPECIFICATION FOR EARTH WORK**

CONTENTS: -



## 1.0 EARTHWORK IN EXCAVATION AND BACKFILLING

1.01 This part of specification covers the general requirements of earthwork in excavation in different types of soil/subsoil strata. filling back around foundations, conveyance and disposal of surplus to spoil to any lead and lift, stacking it properly as directed by Engineer, including all operations covered within the intent and purpose of this specification.

## 2.0 APPLICABLE CODES

2.01 The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to as applicable on the date of opening of the Bids. In case of discrepancy between this specification and IS codes referred to herein this specification shall govern.

a) IS:1200 : Method of Measurement of Building and Engineering works.

b) IS:3764 : Safety code for excavation work.

c) IS:3385 : Code of Practice for measurement of Civil Engineering works.

d) IS:2720 : Part-II , Part-VII, Part-VIII, Part-XXVIII, Part-XXIX - Determination of Moisture Content.

e) IS:4081 : Safety code for blasting and related drilling operations.

f) IS:9758 : Guide lines of dewatering during construction.

g) IS:10379 : Code of practice for field control of moisture and compaction of soils for embankment and subgrade.

## 3.0 GENERAL

3.01 Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the job in accordance with specification's and requirements.

3.02 Contractor shall carry out the survey of the Site before excavation and set properly all lines and establish levels for various works such as earthwork in excavation for forming the embankment, basement, foundations, plinth filling, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/ grid lines at 5M intervals or nearer as determined by Engineer based on ground profile. These shall be checked by Engineer and thereafter properly recorded.

3.03 The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night for ensuring safety.

3.04 The rates quoted by the Bidder shall also include for dumping of excavated materials in regular heaps or bunds with regular slopes as directed by Engineer, within the basic initial lead of 1000 metres and leveling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as directed by Engineer. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the side and the top. Rock shall be stacked separately. The excavated material so stacked and if found suitable for use in the work, shall be used by the Contractor, with the approval of the Purchaser/Engineer.

3.05 If during excavation the Contractor comes across some facility/structures/system he shall immediately intimate the Engineer and carry out the excavation with care under the Engineer's guidance and provide suitable supports/protection required. The Contractor shall include the cost of these in his rates. However, in case the Engineer requires the dismantling of such items and/or diversion facility for the same, it shall be paid for separately at initially agreed rates.

3.06 The earth work in excavation shall include the removal of all materials to properly execute the work. Sides and bottom of excavation shall be cut sharp and trimmed to the required levels.

3.07 If the bottom of any excavation appears to be soft, unsound or unstable the Contractor shall report the matter to the Engineer and if the Engineer so directs, shall excavate it to the directed depth. Such extra excavation shall be filled up with lean cement concrete of grade M.7.5 (1:4:8).

3.08 The Contractor shall perform excavation in such a way as to prevent immediate or future sliding or caving in of the ground. He shall be held responsible for damage to persons, works or things and entirely liable for all and any changes entailed in removal of material collapsed or for other work or supplies eventually required for re-conditioning.

## 4.0 PRECIOUS OBJECTS, RELICS, OBJECTS OF ANTIQUITY ETC.

4.01 All gold, silver, oil, minerals, archaeological 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 Purchaser and Contractor shall duly preserve the same to the satisfaction of Purchaser and from time to time deliver the same to such person or persons as Purchaser may from time to time authorise or appoint to receive the same.

## 5.0 EXCAVATION IN SOILS

5.01 All excavation work shall be carried out by mechanical equipment as far as possible. Side and bottom of excavation shall be cut sharp and true to line and level.

5.02 Excavation for foundation shall be to the bottom of lean concrete and as shown on drawing or as directed by the Engineer. Rough excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below

final level and extra excavation filled up as directed by Engineer. The final excavation if so instructed by Engineer, should be carried out just prior to laying the mud-mat. Any excavation taken out to a depth greater than required for any reason whatsoever shall be filled with lean concrete of grade M-7.5 (1:4:8) by the Contractor at his own cost.

5.03 Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by Engineer, at his own cost

5.04 All excavation shall be done to the dimensions as required for safety and working facility. Working space provided shall not be less than as provided in IS:1200 (Part-I). Prior approval of Engineer shall be obtained by Contractor in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal etc. This approval, however, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur the slipped material shall be removed and the slope dressed to a modified stable slope. Removal of the slipped earth will not be paid.

5.05 Excavation shall be carried out with such tools, tackles and equipment as described herein before.

5.06 **Permissible Tolerances for Slope in Excavation**

| | | | |
|---|---|---|---|
| a) | Hard and soft shale | : | 1 horizontal to 4 vertical |
| b) | Hard and soft moorum with or without boulder | : | 1 horizontal to 4 vertical |
| c) | Normally hard soil not subjected to change of structure due to variation of moisture | : | 1 horizontal to 2 vertical |
| d) | Black cotton soil & other soils | : | 1 horizontal to 1 vertical |

6.0 **EXCAVATION IN ROCK**

6.01 **General**

a) All clauses from 5.01 to 5.06 shall be applicable to excavation in rock also. In case of any discrepancy between the above mentioned clause and those specified in this clause (viz 6.0) then this clause shall govern.

b) For the work of excavation in rock, Contractor shall engage specialized agency having experience of excavation in rock involving wedging and blasting. The agency shall be subject to approval of engineering and the Contractor shall furnish details of relevant experience in support while seeking approval for the agency.

c) In case of overbreaks in rock excavation, the excavated level shall be brought to the level shown on drawing with plain cement concrete of nominal mix 1:3:6 as described in para 5.02.

6.02 The contractor shall obtain license from the district authorities for undertaking blasting work as well as for obtaining and storing the explosives as per Explosives Rules 1940, corrected up-to-date.

6.03 The contractor shall comply strictly with the regulation as required by the authorities regarding purchase, storage, issuance and use of explosives and transport of same to and from site, and shall be deemed to have included in his tender all costs arising from the use, storage and transport of explosives as well as from supervision of blasting by security forces.

6.04 Blasting shall furthermore be strictly and in every case subject to the Engineer's permission.

6.05 All blasting shall be carried out by approved experts only and the contractor shall be fully liable for any claims arising from damage or alleged damage, injury to the public etc due to blasting.

The contractor shall be insured with an approved insurance employer against all claims with respect to damage and injury arising from blasting.

6.06 Fuses, detonators or blasting caps shall not be transported or stored together with dynamite or other explosives. The location and design of the storage places, the transportation methods and the precautions that shall be taken to prevent accidents shall be subject to the Engineer's approval, but it is understood that this approval does not exempt the contractor of his responsibility with regard to the handling of dynamite or other explosives.

6.07 Drilling and blasting plans shall be submitted well in advance for the Engineer's approval prior to commencement of any blasting work.

6.08 When blasting is carried out, trees, structures etc in exposed position shall be adequately protected from damage.

6.09 Drilling and blasting shall be arranged and, where necessary, the rock being blasted shall be protected so as to prevent any scattering of the rock liable to cause injury to the public or damage to dwellings, buildings and other property and the works.

6.10 Blasting shall be carried out carefully to avoid the loosening of rock surfaces that are to remain intact, particularly in those cases where concrete is to be placed directly against these rock surfaces.

## 7.0 PROTECTION

7.01 The Contractor shall provide and maintain required decking, guard fencing, roping, planking, sign boards, red lights, etc. required to maintain safe pedestrian and vehicular traffic and for safety of persons and property.

## 8.0 FILL, BACK FILLING

### 8.01 General

8.01.1 All fill material will be subject to Engineer-in-Charge's approval. If any material is rejected by Engineer, Contractor shall remove the same forthwith from the Site at no extra cost to the Purchaser. Surplus fill material shall be deposited/disposed off as directed by Engineer after the fill work is completed.

8.01.2 No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by Engineer-in-Charge.

8.01.3 Where compaction to 95% Standard Proctor Density or more is called for, it shall be by mechanical means only. Where access is possible, compaction shall be by 12 tonne rollers smooth wheeled, sheep foot or wobbly wheeled as directed by the Engineering.

### 8.02 Material

8.02.1 To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of moorum or earth to fillup the voids and the

mixture used for filling. No expansive soil shall be used for backfilling or plinth filling. No expansive soil shall be used for backfilling or plinth filling.

8.02.2 If any selected fill material is required to be borrowed, Contractor shall make arrangements for bringing such material from outside borrow pits or from Purchaser's acquired land within the specified lead. The material and source shall be subject to prior approval of Engineer. The approved borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish etc. top soil containing salts/sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off as directed by Engineer. Contractor shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.

8.04 **Filling in Pits Around Foundations, Etc.**

8.04.1 As soon as the work in foundations has been completed and accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleared of all debris and filled with earth in layers not exceeding 150mm, each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Engineer. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless Engineer is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and levelled to proper profile as directed by Engineer or indicated on the drawings.

8.05 **Sand Filling:**

8.05.1 At places backfilling shall be carried out with local sand if directed by Engineer. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for twenty four (24) hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to Contractor's account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until Engineer has inspected and approved the fill.

8.06 **Filling in Trenches**

8.06.1 The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the concrete foundation.

8.06.2 Back fill shall not be dropped directly upon or against any structure/facility where there is a danger of displacement or damage. Trucks or heavy equipment for depositing or compacting back fill shall not be used within 1.5 metres of building walls, piers, or other facilities which may be damaged by their weights, operation or method of compaction, subject to approval of Engineer-in-Charge.

## 9.0 FILL DENSITY

9.01 The compaction shall comply with the specified proctor/ modified proctor density at moisture content differing not more than four (4) percent from the optimum moisture content. Test shall be carried out in accordance with relevant part(s) of IS:2720 and all tests shall be made by/or under the supervision of Purchaser at Contractor's own expense.

## 10.0 TIMBER SHORING

10.01 This specification covers the general requirements of timber shoring for excavation of trenches, pits, open excavations etc.

10.02 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 25 cm x 4 cm sections or as directed by Engineer. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal wallings of strong wood at maximum 1.2 metres spacings, strutted with ballies or as directed by Engineer. The length of the ballies struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical wallings, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

10.03 Timber shoring shall be `close' or `open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by Engineer. It shall be the responsibility of Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits etc. from collapsing.

10.04 Timber shoring may be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons such shoring shall be carried out, except in an emergency, only under instructions from Engineer-in-Charge.

10.05 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 with systematically to the other end. Concrete or masonary 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.

10.06 In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width.

The detailed arrangement, sizes of the timber and the spacings shall be subject to the approval of Engineer. In all other respects, specification for close timbering shall apply to open timbering.

10.07 In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. Loads from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

10.08 No extra payment shall be made for timber shoring. This is deemed to be included in the tendered cost.

## 11.0 DEWATERING

### 11.01 Scope

This specification covers the general requirements of Dewatering, Excavation in general.

11.02 Typical bore log details are available with the Purchaser's engineer and can be seen by the Bidder for general information. The Bidder may contact the Purchaser for further details and clarification if any. No claims shall be entertained for actual subsoil conditions being different from those given in the bore log.

11.03 Contractor shall ensure that during excavation ground water level shall be lowered by at least 0.5M below the founding level , adopting appropriate method of dewatering. Lean concrete ( PCC 1:3:6) below foundations shall be laid soon after excavation with minimum loss of time. Pit shall be kept continuously dewatered upto seven days after the last pour of foundation concrete. Above precautions shall be strictly followed to avoid sand boiling conditions and loosening of strata.

11.04 All excavations shall be kept free of water mud or slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. Contractor shall remove by pumping or other means approved by Engineer any water inclusive of rain water and sub-soil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. Method of pumping shall be approved by 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. Pumping arrangements shall be adequate to ensure no delays in construction.

11.05 When there is a continuous inflow of water and quantum of water to be handled is considerable in the opinion of Engineer, a large, well point system - Single stage or multistage, shall be adopted. Contractor shall submit to Engineer his scheme of well point system including the stages, the spacing, number and diameter of well points, headers, etc. and the number, capacity and location of pumps for approval. The cost of dewatering shall be deemed to be included in the tendered cost of works

## 12.0 RAIN WATER DRAINAGE

12.01 This para covers the drainage of rainwater in excavated areas. Grading in the vicinity of excavation shall be such as to exclude rain / surface water raining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same at no extra cost of the Purchaser. The excavated areas shall be maintained in dry working conditions at all times until the excavation, placement of reinforcement, shuttering, concreting, backfilling is completed. The Contractor shall remove all slush / much from the excavated areas to keep the work area dry. Sludge pumps, if required, shall be employed by the Contractor for this purpose. The scheme for pumping and discharge of such water shall be approved by the Engineer.

## 13.0 BENCH MARKS

Throughout the construction the Contractor shall at his own cost establish, construct, protect and maintain all benchmarks and reference points to the satisfaction of the Engineer and provide necessary assistance in taking and recording of all measurements by the Engineer-in-Charge.

## 14.0 SAMPLING, TESTING AND QUALITY CONTROL

### 14.1 General

a) The contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards, and/ or International Standards and shall conduct such tests as are called for by the Engineer. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent

accepted engineering practice to the directions of the Engineer. Tests shall be done in the field and at a laboratory approved by the Engineer and the Contractor shall submit to the Engineer, the test result in triplicate within three days after completion of a test. The Engineer may, at his discretion, waive some of the stipulations given below, for small and unimportant operations.

b) Work found unsuitable for acceptance shall be removed and replaced by the contractor. The work shall be redone as per specification requirements and to the satisfaction of the Engineer.

c) Only as a very special case and that too in non-critical areas, the Engineer may accept filling work which is marginally unacceptable as per the criteria laid down. For such accepted work, payment shall be made at a reduced rate prorate to the compaction obtained against that stipulated.

14.2 **Quality Assurance Programme**

The contractor shall submit and finalise a detailed field Quality Assurance Programme within 30 days from the date of award of the Contract according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus / equipment deployment of qualified/ experienced manpower, preparation of format for record, field Quality Plan etc. On finalized field quality plan the Owner shall identity customer hold points beyond which work shall not proceed without written approval from the Engineer.

14.3 **Frequency Of Sampling & testing**

Frequency of sampling and testing including the methods for conducting the tests are given in the table below. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications.

## TABLE

## FREQUENCY OF SAMPLING AND TESTING

| Sl. No. | Nature of Test/ Characteristics | Method of Test | No. of samples & Frequency of Test | Remarks |
|---|---|---|---|---|
| 1. | EXCAVATION | | | |
| a. | Nature of soil | Visual | Random | |
| b. | Initial ground lavel | Measurement | 100 % | |
| c. | Dimensions of excavated pit | Measurement | 100 % | |
| d. | Final / Pit bed level | Measurement | 100 % | |
| e. | Side slope during excavation | Measurement | Random | |
| 2. | Suitability of Fill Materials | | | |
| a) | Grain size Analysis | IS :2720 (Part IV) | One in every 2000 $m^3$ for each type and each source of fill materials subject to a minimum of two samples | Test for Soil and sand |
| b) | Liquid limit and plastic limit | IS:2720 (Part V)<br><br>IS:2720 (Part | -- do --<br><br>One in every 5000$m^3$ for each type and | Test for Soil |

| Sl. No. | Nature of Test/ Characteristics | Method of Test | No. of samples & Frequency of Test | Remarks |
|---|---|---|---|---|
| c) | Shrinkage limit | VI) | each source of fill material | The frequency for test shall be increased depending on type of soil |
| | | | -- do -- | |
| | | IS:2720 (Part XI) | | -- do -- |
| d) | Free swell index | | -- do -- | |
| | | IS:2720 | -- do -- | -- do -- |
| e) | Chemical Analysis | | | |
| | | (Part XXII) | | Test for sand and soil |
| | i) Organic matter | (Part XXIII) | | |
| | ii) Calcium carbonate | (Part XXVI) | | |
| | iii) pH | (Part XXVII) | | |
| | iv) Total soluble sulphate | | One in every 2000m³ for each type and each source of fill subject to minimum of 2 samples | |
| | | IS:2720 | | Test for soil for determining optimum moisture contented. Dry Density etc. |
| 3. | Standard Proctor Test | (Part VII) | | |
| | | | -- do -- | |
| | | | | Test for Soil |
| | | IS:2720 | | |
| 4. | Moisture content for fill before compaction | (Part II) | | |
| | | | i) For foundation filling, one for every 10 foundations for each compacted layer. However, each layer for location of import and heavily loaded foundations | |
| 5. | Degree of compaction of fill | | | Test for soil |
| | Dry density by core | IS:2720 | | |

| Sl. No. | Nature of Test/ Characteristics | Method of Test | No. of samples & Frequency of Test | Remarks |
|---|---|---|---|---|
| a) | cutter method.<br>Or<br>Dry density in place by sand displacement method. | (Part XXIX)<br><br>IS: 2720<br>(Part XXVIII) | resting on fill shall be tested.<br><br>ii) For area filling, one for every 1000m²are for each compacted layer<br><br>-- do -- ( i & ii )<br><br>Random checks to be carried out for each compacted layer in additional to tests mentioned under 5(a) above | |
| b) | Relative density<br>(Density Index) | IS:2720<br>(Part XIV) | | Test for sand |
| c) | Dry Density by proctor needle penetration | Standard Practice | | Test for soil |

14.4 **Acceptance Criteria**

Following Acceptance Criteria shall be followed.

a) All individual samples collected and tested should pass without any deviation when only one set of sample is tested.

b) For re-test 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.

d) Tolerance on finished levels for important filling areas at approved interval shall be +/-20mm. However, for an unimportant area, tolerance upto +/-75mm shall be acceptable at the discretion of the Engineer. However, these tolerance shall be applicable for localized areas only.

**Annexure-3**
**STANDARD TECHNICAL SPECIFICATIONS FOR ROADS, DRAINS & CULVERTS**

**CONTENTS :**



1.00 **SCOPE**

The scope of work covered by this specification shall comprise of :

1.01 **A. Roads, Drains and Culverts**

i) Excavation in all types of soils for drains/roads/culverts.

ii) Preparation of subgrade, subbase, base and Asphalt surfacing for roads in accordance with relevant IRC codes

iii) Grade the areas around the drains to augment the flow of surface water into the drains and subsequent disposal.

iv) For crossing of drains, pipes, cable trenches etc. suitable culverts shall be provided.

1.02 **B. Miscellaneous Works**

All other works required for the satisfactory completion of the subject works, even though not specifically mentioned herein.

## 2.00 ROADS

### 2.01 Scope

The contractor shall furnish all labour, materials and equipments required for the construction of all embankments and roads as per these specifications and those prescribed by Indian Road Congress.

### 2.02 General

a) All road shall be constructed in accordance with IRC 37, IRC 19.

b) The roads shall be of width as shown on drawings with shoulders on both sides.

### 2.03 Quality Control:

2.03.1 The Contractor shall establish and maintain quality control for the various aspect 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.

2.03.2 Permitted tolerances for road works are described hereinafter.

I) **Horizontal Alignment:**

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the approved drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25 mm there from. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± *40 mm.*

II) **Longitudinal Profile:**

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, and shall not exceed the tolerances mentioned below:

| | |
|---|---|
| Sub-grade | ± 25 mm |
| Sub-base | ± 20 mm |
| Base course | ± l 5 mm |
| Wearing course | ± 10 mm |

Tolerance in 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.

III) **Surface Regularity of Subgrade and Pavement Courses:**

The surface regularity of completed sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated In Table-1.

The longitudinal profile shall be checked with a 3 metre 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 interval of 10 m.

**TABLE – I**

**PERMITTED TOLERANCE OF SURFACE REGULARITY**

FOR PAVEMENT COURSES

| | Type of Construction | **Longitudinal Profile with 3 metres Straight Edge** | | | | | **Cross Profile** |
|---|---|---|---|---|---|---|---|
| | | Maximum Permissible Undulation (mm) | Maximum number of undulations permitted in any 300 meters length 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 (45-90mm size) | 15 | - | 30 | - | - | 12 |
| 4 | Water Bound Macadam with normal size metal (22.4 -53mm size and 45-63 mm size), | 12 | - | - | 30 | - | 8 |
| 5 | Premix carpet, mix-seal surfacing | 10 | - | - | - | 30 | 6 |
| 6 | Asphaltic concrete | 8 | - | - | - | 10*** | 4 |
| 7 | Bituminous macadam | 10 | - | - | - | 20*** | 6 |

**NOTES:**

1.*** 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.

2. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

**2.04 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.

Specification for road and bridge works of Ministry of surface & Transport Published by the IRC.

a) IRC-19 Standard specifications and Code of Practice for Water Bound Macadam.

b) IRC: SP-11 Hand Book of Quality Control for Construction of Roads and Runways.

c) IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete

d) IS:2212 Code of Practice for Brickwork.

e) IS:783 Code of Practice for Laying of Concrete Pipes.

f) IS:73 Specification for paving bitumen.

g) IS:215 Road Tar specification

h) IS:217 Specification of cutback Bitumen

i) IS:454 Cutback bitumen from waxy crude -Specification

j) IS:460 Specification for test sieves: Part I Wire cloth test sieves

k) IS: 1077 Common burnt clay Building bricks

l) IS:1124 Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.

m) IS:1195 Specification for bitumen mastic flooring

n) IS:1834 Specification for hot applied sealing compound for Joints in concrete

o) IS:2386 Methods of tests for aggregates for concrete

p) IS:2720 Methods for test for soils

q IS:6241 Method of Test for Determination of Stripping value of road aggregates

r) IRC:16 Specification for Priming of Base Course with Bituminous Primers

s) IRC:17 Tentative Specifications for Single Coat Bituminous Surface Dressing

t) IRC:29 Specification of Bituminous Concrete(Asphaltic Concrete) for Road pavement

u) IRC:37 Guidelines for the Design of Flexible Pavements.

v)Other specifications mentioned elsewhere in this specification.

In case any particular aspect of work is not covered specifically by the specification / Indian Standard Specification, any other standard practices as may be specified by the Engineer shall be followed.

## 2.05 Earth Work

### 2.05.01 Earth Work in excavation

Excavation shall include cutting or loosening and removing earth including rock from its original position, transporting and dumping it as a fill or spoil bank. Earth work excavation work shall be divided as excavation or cutting, grading and compaction. The depth of excavation is decided on the requirement of vertical profile of the Road. The slope to be provided is governed by the type of soil and the depth of the cutting. Construction of side drains, where applicable, also require excavations along road side. Sides and bottom of excavation shall be cut sharp and the under-cuttings will not be permitted. The bottom of excavation shall be trimmed to the required levels by

chiselling and when carried out deeper by error shall be brought to level by compacted backfill to the satisfaction of the Engineer at the cost of the Contractor.

2.05.02 **Earth Work in Embankment**

a) When it is required to raise the grade line of Road above the existing ground level it may be necessary to construct embankment.

b) The embankment shall be formed of earth obtained either from borrow pits or from places as directed by the Owner/Consultant.

c) The height of the embankment shall depends on the desired grade line of the Road and the soil profile or topography. It also governed by stability of slopes, particularly when the foundation soil is weak.

d) Before commencing any embankment, the foot of the slope of each side shall be marked by pegs driven into ground at interval of 5 meter or by a continuous dag-belling to indicate the limits of side slopes. Earth profiles shall then be set up for guidance of the workers at intervals along the embankment. These profiles shall show the total height of the embankment with due allowance for settlement.

e) Before placing any embankment material, after clearing and grubbing, the top 150 mm of soil strata receiving it shall be scarified, watered and compacted with 8-10T roller so as to achieve minimum dry density of 95% as per IS:2720 (part 8). No mud, slush or decayed matter of any kind shall be used. Embankment shall be raised in regular layers not exceeding 150mm thick. They shall be carried out to the full width upto the slopes, so that no additional earth is required for the slope. Clods above 75mm shall be broken up.

f) Each layer of earth shall be adequately watered to aid compaction. Each layer shall be rolled not less than 6 times with roller of minimum 8-10 tonne weight till it gets evenly and densely consolidated. Each layer below top 500 mm thick subgrade shall be compacted to a minimum of 95% maximum dry density where as each layer in the top 500 mm thick subgrade shall be compacted to a minimum of 97% maximum dry density. Where roller cannot work, the earth shall be consolidated with wooden or steel rammers of 7 to 10 kilograms weight having a base of 200mm square; or 200mm diameter. The labour for ramming shall be atleast one rammer to six (6) diggers. Before placing the next layer, the surface of the underlayer shall be moistened and scarified with pick axes or shades, so as to provide a satisfactory bond with the next layer. The top of embankment shall be brought to the proposed levels and shall be neatly finished. On embankment slopes proper slope protection measures such as turfing /stone pitching shall

be laid.

2.05.03 **Preparation of sub-grade**

a) The preparation of sub-grade includes all operations before the pavement structure could be laid over it and compacted. Thus the preparation of sub-grade shall include site clearance, grading and compaction. The grading operation is started so as to bring the vertical profile of the sub-grade to designed grade and camber.

b) The surface of the formation to width equal to that of soling course shall first be cut to a depth below the proposed finished level, equal to the combined depth of soling and wearing course with due allowance being made for consolidation.

c) It shall then be cleaned of all foreign substances. Any ruts or soft yielding places that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile.

d) The contractor shall carryout CBR test in soaked and unsoaked conditions of sub-grade as per IS:2720 (Part - XVI).

E) Minimum 500mm depth of the subgrade of the road shall be compacted to a minimum of 97% of max. dry density.

2.05.04 **Preparation of Cut-formation**

The cut formation shall be prepared to receive the sub base/base course as directed by the Engineer. Any unsuitable material encountered shall be removed and replace by good material.

2.05.05 **Sub-base / Base course**

The construction of water bound macadam (WBM) shall be carried out in accordance with IRC-19.

The thickness of sub base shall not be less than 150mm and base course shall not be less than 150mm.

The sub-base course shall be provided either with moorum or with water bound macadam.

2.05.5.1 **Sub-base (Granular Sub-base)**

**a)** Descriptions

This work shall consist of laying and compacting well graded material on prepared sub-grade in accordance with the requirements of these 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.

2.05.5.2 **Materials**

The material 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 mixed materials shall be free from organic or other deleterious constituents and conform' to one of the three grading given In Table-2 below.

**TABLE -2**

**Grading for Granular Sub-base Materials**

| Sieve designation | Percent by weight passing the sieve | | |
|---|---|---|---|
| | Grading 1 | Grading 2 | Grading 3 |
| 80mm | 100 | 100 | 100 |
| 63mm | 90-100 | 90-100 | 90-100 |
| 4.75mm | 35-70 | 40-90 | 50-100 |
| 75micron | 0-20 | 0-25 | 0-30 |
| CBR value (minimum): for fraction of material passing 20mm sieve | 30% | 25% | 20% |

**Note:** The material passing 425 micron 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.

**i. Physical Requirements**

The fraction of material passing 20 mm sieve shall give a CBR value as specified In Table-2 when tested in accordance with IS:2720 (Part XVI) after preparing the samples at maximum dry density and optimum moisture content corresponding to 1 S:2720 (Part VII) and soaking the same In water for 4 days.

2.05.5.4 **Spreading and Compacting**

a) Immediately prior to the laying of sub-base, the sub-grade already finished shall be prepared by removing all vegetation and other extraneous matter (for a depth of 20 cm), lightly sprinkled with water, if necessary, and rolled with one pass of 8-1 0 tonne smooth wheeled roller.

b) The sub-base material shall he 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 the layer after compaction does not exceed 150 mm.

c) 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.

d) 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.

e) Rolling shall be continued till the density achieved is at least 100% 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.

2.05.05.5 **Water Bound Macadam**

**Material**

a) Coarse aggregate shall be either crushed or broken stone. It shall be hard, durable and free from excess of flat, elongated soft and disintegrated particles, dirt and other objectionable matter. The materials shall meet the physical requirements of coarse aggregate as per IRC standards when tested as per IS:2386

b) Aggregate conforming to grading No. 1 having aggregate size of 90mm to 45mm shall be used for preparation of sub base. Grading NO.2 (Size 63mm to 45mm) & grading No.3 (Size 53mm to 22.4mm) shall be used for

preparation of base. All grading shall be in accordance with IRC standard.

c) Screenings for sub base course shall conform to Grading type A (13.2mm size)and shall conform to Type B (11.2 mm size) for base course. Screening to fill voids in the coarse aggregate shall generally consist of the same materials, moorum or gravel. Moorum or gravel as screening material may be used provided Liquid limit and Plasticity Index of such material is below 20& 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent. All grading shall be in accordance with relevant IRC specification.

d) Binding material to be used for WBM construction shall comprise of a suitable material approved by the Engineer having plasticity index value of less than 6 as determined in accordance with IS:2720 Part (V).

e) Camber shall be provided in all layers of the pavement including the sub grade.

2.05.5.6 The coarse aggregate shall be uniformly spread upon the prepared base in such quantities that the thickness of the compacted layer is 100mm for grading 1 and 75 mm for grading 2 & 3. The aggregate shall not be dumped in heaps directly on the surface prepared.

2.05.5.7 Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power roller of 8 to 10 tonne capacity rollers of approved type. First the edges shall be compacted and then moved inwards parallel to the center line of the road. During rolling slight sprinkling of water may be done.

2.05.6 **Application of Screenings**

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. Dry rolling shall be done while the screenings are being spread. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers.

The screening consists of aggregate of smaller size, generally if the same material as the coarse aggregate. After the application of screenings, the surface is sprinkled with water, swept and rolled. Wet screenings are swept into the voids using hand brooms. Additional screening are applied and rolled till the coarse aggregates are well bonded and firmly set.

2.05.7 **Sprinkling & Grouting**

After the application of screenings, the surface is sprinkled with water, swept and rolled. Wet screenings are swept into the voids using hand brooms. Additional screenings are applied and rolled till the coarse aggregates are well bonded and firmly set.

2.05.8 **Application of Binding Material**

Binding material consisting of fine grained material is used to prevent gravelling of the stones, plasticity index of binding material shall be less than 6%. After the application of screening and rolling, binding material is applied at a uniform and slow rate at two or more successive thin layers. After each application of binding material, the surface is copiously sprinkled with water and wet slurry swept with brooms to fill the voids. This is followed by rolling with a 6 to 10 tonne roller and water is applied to the wheels to wash down the binding material that sticks to the roller.

2.05.9 **Setting and Drying**

After final compaction, the WBM course is allowed to set over-night. On the next day the 'hungry' spots are located and are filled with screenings or binding material, lightly sprinkled with water if necessary and rolled. No traffic is allowed till the WBM layer sets and dries out. In the case of WBM base course, the layer is allowed to dry completely without permitting traffic to ply and then the bituminous surfacing is laid. Limited construction traffic may be permitted to ply over the WBM layer taking proper care not to damage the layer.

2.05.10 **Edging**

Brick edging shall be provided between the toe of WBM & prepared base. Edging shall be done 225 wide and 115mm deep or as specified with 1st class bricks. Trenches shall first be made along the edges of wearing coat of the road to receive bricks. Bricks shall be laid on edge with its length across the road cutting and running parallel to the road edge, true to line and gradient.

2.05.11 **Shoulders**

Shoulders shall be of 150mm thick granular moorum.

2.05.12 **Tack Coat**

a) **Description**

The tack coat shall consist of application of a single coat of low viscosity liquid bituminous material to an existing Road surface preparation for laying of the carpet.

b) **Materials**

Binder : The binder used for tack coat shall be bitumen of a suitable grade as directed by the Engineer and conforming to 1S:73, 217 or 454, as applicable, or any other approved cutback.

c) **Construction Operations**

**i) 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 material before the application of the binder.

d) **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 meter -area for an existing bitumen treated surface and 10 kg per 10 square meter 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 on coming bituminous construction.

## 2.05.13 Bituminous Macadam Surfacing

Bituminous Macadam shall be used as a binder course. The minimum thickness of this layer shall be 50 mm.

### ***2.05.13.1*** *Materials*

The grade of bitumen used is 80/100 penetration. Road tar Rt-4, cutback and emulsion can also be used in cold mix construction technique. The binder content used shall be 4.0 percent by weight of mix.

For binder course maximum recommended abrasion and impact values of aggregate are 40% and 30% respectively.

The quantity of aggregates required for 10 $m^2$ of 50mm thickness bituminous macadam shall be 0.6 to 0.75 $m^3$ .

Grading of Aggregate for Bitumen Bound Macadam shall be as follows:

| Percent passing Sieve size, mm | Bitumen Bound Macadam compacted thickness, 50 mm |
|---|---|

| | I | II |
|---|---|---|
| 63 | - | - |
| 50 | 100 | 100 |
| 40 | - | 90-100 |
| 25 | 35-70 | 50-80 |
| 20 | - | - |
| 12 | 0-15 | 10-30 |
| 10 | - | - |
| 4.75 | - | - |
| 2.36 | 0 -5 | - |
| 0.075 | 0 -3 | 0-5 |

2.06 **Asphalt Surfacing**

50mm thick asphaltic concrete shall be provided over prepared base.

a) Binder :
The binder shall conform to IS:73

b) Coarse aggregates :
This shall consists of angular fragments and clear, hard, tough, durable & uniform quality throughout.

c) Fine aggregates :
The fine aggregates or sand shall be clean, hard, durable, coarse particles & free from dust, organic matter etc.

Aggregates gradation shall be Grading 2 with sieve size 22.4 mm to 90 microns and percentage of binder content by weight of total mix shall be 5.5 to 7.5.

2.06.1 **Mix Design for Asphaltic Concrete**

Marshall mix design criteria for Asphaltic concrete shall be as follows:-

| | Test Property | Medium Traffic |
|---|---|---|
| a) | Stability, kg(minimum) | 340kg (minimum) |
| b) | Flow value,0.25mm units | 2 – 4 |
| c) | Maximum Air voids in total mix % | |

for surfacing 3 – 5

d) Compaction blows 50

The job mix formula proposed by the contractor shall be got approved by the Engineer before commencement of asphalting works.

2.06.2 **Preparation of Base**

The under lying base on which the Asphalt carpet is to be laid shall be prepared as directed by the Engineer. The surface shall be well cleaned by removing caked earth & other foreign matter with wire brushes, sweeping with broom & finally dusting with sacks. Before laying premix carpet the base surface shall be properly leveled for any undulations etc.

2.06.3 **Preparation of Premix**

The mixing of aggregate with bituminous binder shall be done in mixers. The binder shall be heated in boiler to the temperature appropriate to the grade of bitumen approved by Engineer. The aggregate shall be dry when placed in mixer. The bitumen binder content shall be so fixed as to achieve the requirements of the mix setforth in Cl.2.05.1

2.06.4 **Spreading & Rolling**

The premixed material shall be spread on the road surface with rakes to the required thickness & camber. As soon as sufficient length of bituminous material has been laid, rolling shall commence with 6 to 10 tonne power rollers.

2.07 **Seal Coat**

2.07.01 **Description**

This work shall consist of application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and camber.

Seal coat shall be of either of the two types below, as specified:

Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder. (Type B)

2.07.2 **Materials**

2.07.2.1 **Binder**

The binder shall be bitumen of a 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 straight run bitumen shall be 6.8 kg per 10m2 area.

2.07.2.2 **Fine Aggregate for 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 meter per 10 square meter area.

2.07.3 **Construction Operations**

2.07.3.1 **Preparation of Base**

The seal coat shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat materials the surface shall be cleaned free of any dust or other extraneous matter.

2.07.3.2 **Construction**

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 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 are 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 6-10 tonnes smooth wheeled power rollers. Rolling shall be continued till the pre-mixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

3.0 **DRAINS/CULVERTS**

3.01 **Scope**

The scope of work covered under this specification in general shall comprises of construction of surface drain, sub surface drains and culverts. At road crossings 300mm diameter pipes on two perpendicular directions shall be provided for pipe cable crossing.

The contractor shall furnish all labour, materials and equipment's required for the construction of all drains including connection with RCC hume pipes and construction of culverts at location of road crossing, wherever required as per drawings or as directed by engineer.

3.02 **Materials**

Drains shall be made of reinforced concrete and culverts shall be RCC box culvert.

3.03 **EXCAVATION**

Excavation shall be done along the layout and to the depths and shall include removal of all materials. The bottom of the excavation shall be trimmed to correct levels as per the gradient specified.

3.04 **GENERAL**

1. Surface drains shall be provided along the sides of the Roads or pavements or embankments to collect surface water.

2. Minimum size of drain shall be 300mm wide and 300mm deep.

3. The surface drain should have sufficient capacity and longitudinal slope to carry away all surface water collected.

4. Side drains shall be provided at the edges of right of way where the road is in embankment and at the edges of road way, if in cutting. The out fall should be to the diverted Nallah. Longitudinal bed slope not milder than 1 in 1000 shall be provided.

5. All buildings and paved areas in the power plant area shall be provided with catch drains for collecting the surface water, and rain water through down comer pipes. The drains shall be provided with precast RCC covers with grated openings.

6. The water collected in the drains shall be led to a main drain and disposed off at the nearest stream, valley or water course.

7. Whenever the drains have to cross the roadway, cross drainage such as culverts should be provided.

4.0 **Drains**

The specifications for the construction and materials besides measurement shall be as indicated below.

4.01 **RCC Drains**

The bottom slab and walls shall be of 100mm thick (minimum) in RCC grade M20. The inside of drains shall be finished neat with a floating coat of neat cement concrete. Honey combing in concrete shall be finished with plaster in CM 1:4.

4.02 **Box Culvert**

The box culverts shall be designed for class A loading as per IRC. Box culverts shall be RCC grade M20.

## 5.00 SUPPLYING, LAYING AND JOINTING OF RCC PIPES

### 5.01 Supply Of Pipes

At locations where surface drains cannot be provided, under ground pipes shall be provided to drain the water or oil. The reinforced cement concrete pipes to be used shall be of Class NP-2 / NP-3 conforming to IS:458 – latest edition, all as specified on drawings and directed by Engineer. For road or railway crossings higher class of pipe ( NP-4 ) or plain concrete / RCC encasement, as required from designs, shall be provided to take care of higher loads. The pipes supplied shall be in good condition. Contractor shall obtain and submit to Engineer the test certificates from manufacturer / recognized test house.

### 5.02 Alignment, Level and Grade

The work shall be carried out in conformance to the alignment, levels and grades specified on the drawings. The layout and levels shall be made by him at his cost from one reference grid and bench mark given by Engineer. Contractor shall extend all help by providing instruments, materials and manpower to Engineer for checking the layout and levels as and when required by Engineer.

Making of reference layout and level pillars along the pipeline route and maintaining them till completion of the work shall be the responsibility of Contractor at his cost.

### 5.03 Laying Of Pipes

Utmost care shall be exercised in loading, transporting and unloading of the concrete pipes to avoid impact and damage. All pipe sections shall be inspected carefully before being laid. Broken or defective pipes shall not be used.

The pipe laying shall conform to IS:783 – latest edition. Pipes shall be laid on ordinary earth prepared bedding / cement concrete cradle bedding to suit site conditions as per approved construction drawings. Different bedding conditions are given in Appendix-B of IS:783.

The bedding must be even and uniform projecting rock faces and boulders should be removed before forming the bedding. They should be lowered in the trenches carefully using mechanical means. Pipes shall be laid true to line and grade as specified. Laying of pipes shall always proceed upgrade of slope. The pipes should be laid in position before the concrete has set . Where two or more lines of 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. Normally it is to be ensured that the pipe has a cushion of at least 0.6 m over the crown.

5.04 **Jointing Of Pipes**

Sections of pipes shall be jointed together in such a manner that there shall be as a little unevenness as possible along the inside of the pipe and it should be true to grade and levels and alignments. All the pipes shall be watertight.

The pipes are to be flush jointed with specially shaped ends of the pipe and the jointing space of 1.3 cm shall be filled with cement mortar of 1:2 proportion mixed in sufficient consistency so as to remain the position when forced with a trowel or rammer. The finished joint shall be flush at both inside and outside of the pipe wall.

5.05 **Hydrostatic Testing Of Pipes**

The pipeline as laid shall be subjected to hydrostatic testing as per Clause 15.5 of IS:783.

**Annexure-4**
**STANDARD TECHNICAL SPECIFICATIONS FOR DRAINAGE, SANITATION & WATER SUPPLY**

CONTENTS :



1.0 **GENERAL**

All pipelines, locations of fittings and fixtures, etc., shall be as per the approved construction drawings and as directed by engineer incharge. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall fully secured against movement in any direction and so located as to allow maintenance where desired by Engineer.

All pipelines and fittings fixtures shall be installed leakproof. When the works under scope of this specification connect with others the connection shall be such as to prevent any splashing or emission of foul odour and gases.

2.00 **SANITARY APPLIANCES**

2.01 **Scope**

The Contractor shall furnish all labour, materials and equipment required for supply and installation of various sanitary appliances required for the civil works as per drawings and specifications.

2.02 **Wash Basins**

Wash basins shall be of white vitreous china clay of standard size 630 mm x 450 mm with flat back. Wash basin shall be one piece construction including a combined overflow and a soap holder. Wash basins shall be provided with approved quality chromium plated pillar taps (15 mm) dia (hot and cold) alongwith chain and plug stop cocks, brackets, complete. The wash basins shall in all respects conform to IS:2556 (Part- IV. Wash basins shall be

provided with 32 mm dia CP bottle trap and waist, 75 mm CI Nahani floor trap and connecting pipes

2.03 **Sink**

It shall be made of galzed stoneware. It shall be wall hung by painted cast iron brackets and complete with one brass faucet with nylon washers, waste chain, waste washers, lead waste pipe with traps, perforated waste with necessary fittings. All fittings including faucets shall be chromium plated.

2.04 **Bathroom Mirror**

It shall be made of the best quality 6mm thick glass of size 600mmx450mm bevelled edge and produced by a reputed mirror manufacturer. It shall be wall mounted with adjustable revolving brackets. The brackets, screws and other fittings shall be chromium plated.

2.05 **Glass Shelves**

Glass shelves shall consist of 6mm thick clear glass with guard rails and shall be wall mounted with brackets. All brackets, guard rails and screws shall be chromium plated.

2.06 **Towel Rail**

Towel rails shall be 20mm dia 800mm long chromium plated MS pipes wall mounted with steel brackets. The brackets, screws etc. shall also be chromium plated.

2.07 **Soap Holder**

It shall be made of chromium plated strong members. The holders shall be wall mounted with chromium plated screws.

2.08 **Liquid Soap Dispenser**

It shall be round and easily revolving with removable threaded nozzle. The body bracket for wall mounting and screws shall be chromium plated.

2.09 **Toilet Roll Holder**

It shall be made of glazed viteous china with suitable cover cum cutter of size 150mmx150mm. Wall mounting screws shall be chromium plated.

2.10 **Installation**

All plumbing fittings and fixtures shall be installed in most workmanlike manner by skilled workers. These shall be perfect in level, plumb, plane, location and symmetry. All items shall be securely anchored to walls and floors. All cuttings in walls and floors shall be made good by the Contractor.

2.11 **Lipped Urinals**

The urinals shall be with flat back and lipped in front. These shall be of white vitreous china. the urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixing holes of minimum dia of 6.5 mm on each side. Each urinal shall have an integral flushing rim and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weephole at theflushing inlet of the urinal. At the bottom of the urinal, an outlet for connecting to an outlet pipe shall be provided. The exterior of the horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the outlet pipe. The inside surface of the urinal shall be smooth throughout to ensure efficient flushing. The bottom of the pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. For every three (3) number urinals there shall be one (1) number of automatic cast iron flushing cistern conforming to IS:774, stop cocks, connecting pipe, flush pipe etc. complete for proper functioning of the urinals. A vitreous china screen shall be provided after every urinal.

2.12 **Water Closet Indian Type**

Indian type WC shall be of Orissa patten of size 580 mm. Each pan shall have a integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weephole at the flushing inlet of the pan. The flushing inlet shall be in the front unless otherwise specified or as ordered by the Engineer. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing. In all cases a pan shall be provided with a 100 mm `P' trap with approximately 50 mm effective water seal and 50 mm diameter vent horn, where required by the Engineer. Each pan shall be provided with a cast iron flushing cistern of (15 litres capacity) approved manufacture and quality alongwith telescophic flush pipe, stop cocks, taps, floor traps, connection pipe etc. complete for proper functioning of the pan and shall conform to IS:2556 (Part-III).

2.13 **European Type**

European Type WC pan shall be of white vitreous china and shall be of wash down type. The closet shall be of one piece construction. Each water closet shall have four (4) holes having a minimum diameter of 6.5mm for fixing to floor and shall have an integral flushing rim of suitable type. Each water closet shall have an integral 'P' trap outlet side of the trap. The water closet when sealed at the bottom of the trap. The water closet when sealed at the bottom of the trap in line with the back plate shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet as installed.

Each water closet shall be provided with a standard low level cistern of approved quality and manufacture, hard rubber seat of approved quality, telescopic flush pipe, connection pipe, stop cock taps, floor traps etc. complete for proper functioning of the water closet. European type water closet shall conform to IS:2556 (Part-II)

2.14 **General**

The work shall be carried out, complying in all respects with the requirements of relevant Indian Standards and Bye-laws of the local authority. any damage caused to the building or to electric, sanitary, water supply or other installation etc. therein, either due to actual requirements of the work, shall be made good and the building and the installation shall be restored to its original condition by the Contractor. Nothing extra shall be paid for it, except where otherwise specified.

For making good the damage to masonry work, concrete work, plastering and many other items shall be as specified in this specification.

All sanitary appliances including sanitary fittings, fixtures, toilet requisites, shall be of size, make and design as specified in the item work and as per sample approved by the Engineer. Samples of all fittings shall be got approved before supply. All sanitary and plumbing work shall also be got approved. On completion of the work the site shall be cleaned and all rubbish disposed off as directed by the Engineer.

2.15 **G.I. Pipes**

2.15.1 The pipes shall be galvanised mild steel welded pipes and seamless screwed and socketed tubes conforming to the requirements of IS.1239, for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanised on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

2.15.2 All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS.554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

2.15.3 The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as specified for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS.554. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

a) The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening bent and damaged screw threads and shall not be used for turning of the threads so as to result in a water tight joint. The screw-threads of pipes and fitting shall be protected from damage until they are fitted.

b) The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed end of the pipe. The end shall then be screwed in the socket, tee, etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of soil or any other foreign matter.

c) Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

2.15.4 a) For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm. clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried. Where directed by the Engineer, a M.S. pipe sleeve shall be fixed at a place where a pipe is passing through a wall or floor for reception of the pipe and to allow

freedom for expansion/contraction and other movements/maintenance. In case the pipe is embedded in walls or floors it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as directed by the Engineer.

b) G.I. Pipes with socket and spigot ends shall be provided with lead caulked joints wherever specified and the joints shall conform to the requirements of IS.3114.

2.15.5 a) The work of excavation and backfilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches for pipes laid underground.

b) The pipes shall be laid on a layer of 7.5 cm sand and filling upto 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. When excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 7.5 cm minimum.

2.15.6 The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as specified by the Engineer and shall satisfactorily pass the test. Pipe line system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully charged with water allowing all air to escape. All draw off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped, the section of the pipeline shall maintain the test pressure for at least half an hour. Any joints or pipes found leaking shall be removed and replaced by the Contractor without extra cost.

2.15.7 The G.I. Pipe line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends of the pipes shall be threaded. The meter and stop cock shall be fixed in position by means of connecting pipe. G.I. nuts, sockets, etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed and meter installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow Care shall be taken that the factory seal of the meter is not disturbed. Whenever the meter is to be fixed to a newly fitted pipe line, the pipe line will have to be completely washed before fixing the meter. For this purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

2.15.8 G.I. pipes with fittings completely fixed in position shall be measured and paid for based on the finished centre line lengths.

## 3.00 PIPING AND DRAINAGE

### 3.01 Scope

This section covers the layout and construction of drains for roof water, surface water and sewage together with all fittings and fixtures and inclusive of ancillary works, such as connections, manholes and inspection chambers used within the building and from the building to the connection to a public sewer or to treatment work, septic tank and soak pit dispersion trenches.

### 3.02 General

All pipe lines, locations of fittings and fixtures, etc. shall be as per drawings or as directed by the Engineer. Correctness of lines, plumb, orientation, symmetry and levels shall be strictly ensured. All items shall be fully secured against movement in any direction and so located as to allow easy maintenance.

All pipe lines, fittings and fixtures shall be installed leakproof. When the works under scope of this specification linked up with works executed by other, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

### 3.03 Rain Water Pipes

Rainwater downtak pipes shall be minimum 100 mm dia UPVC pipes. In case where specifically desired MS pipes may also be used. MS pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer. Rain water pipes shall be adequately provided to drain out the rainwater without overflow. Minimum 100mm diameter pipe shall be provided to drain out 40 Sqm. of roof surface area and minimum 150mm diameter to drain out 80 Sqm. of roof surface area. All vertical down spout pipes and pipefittings shall run inside the walls. All vertical down spout pipes shall be connected to water proof roofing by means of lead funnels protected at the outside by a cover net of brass wire or by $90^0$ bends (elbow).
All covers for water collecting pits, both inside and outside the buildings, shall be of cast iron, with proper holes, and designed to withstand any possible transient load. Such cast iron covers shall be of commercial size and as far as possible the closest to far indoor pits minimum 250mm x 250mm and for outdoor pits 600 x 600mm.

Cast iron pipes shall be straight and perfect in every detail, of uniform thickness and with smooth internal surface free from any casting faults, and shall comply with IS:1230. Pipes to be embedded in masonry shall be fixed in the masonry work as it proceeds. Care shall be taken to keep the pipes

absolutely vertical or to the lines as directed by the Engineer. Pipes shall have a surrounding of 12mm minimum thickness of mortar at every position of the external surface. The mortar shall be of the same mix as is used in the masonry. The joints shall be caulked in with lead as soon as the next length of pipe is placed in position. The open end (socket end) of the pipe shall be kept closed till the next length of pipe is fitted and jointed to prevent any brick bats or concrete or pieces of wood falling in and choking the pipe. The spigot end shall butt the shoulder of the socket and leave no gap in between. The annular space between the socket and the spigot will be first well packed in with spun yarn leaving 25mm from the lip of the socket for the lead. The joints shall then be lead caulked as described in IS:3114. Cast iron pipe fittings shall be of standard size, and shall ring clearly when struck all over with a light hand hammer. The thickness of fittings and details of spigots and sockets shall be same as those of the corresponding size of straight pipes.

3.04 **Gutters**

The gutters shall be made of GI aluminium (INDAL). All gutters shall be supplied by reputable specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform, GI gutters shall have the edges strengthened by suitable means.

Unless noted otherwise the gutters shall have a minimum fall of 1 in 120. adequate number of string supports shall be provided so that there is no reflection even when the gutter is full. Each joint must have a support. Unless otherwise specified the supports shall be fabricated MS brackets. All junctions shall be thoroughly watertight. The joints may be made by riveting, bolting or soldering. All joints between successive lengths of gutters shall have an overlap of at least 5cm. The drop in the overlap shall always be in the direction of the fall of the gutter. Ends of gutters shall be closed watertight. Junction with rainwater down comers shall be made fully watertight and secured.

3.05 **Soil and Drainage Pipes**

**a. *Gradients***

If not specified the minimum gradients of soil and drainage pipe line shall be as follows:

| | |
|---|---|
| 100m nominal | 1 in 35 |
| 150m nominal | 1 in 65 |
| 230mm nominal dia | 1 in 120 |
| 300mm nominal dia | 1 in 200 |

**b. *Relation With Water Supply Pipe Lines***

Unless specifically cleared by the Engineer, under no circumstances shall special drainage

and soil pipes be allowed to come close to water supply pipelines.

**c. *Support and Protection of Pipelines***

All pipes shall be laid with sockets leading uphill. Preferably the pipe shall rest on solid and even foundations for the full length of the barrel. However, the pipe manufacturer's instruction as approved by the engineer shall be followed in the matter of support and jointing.

To achieve full and continuous support, concrete for bedding and packing is the best. Where pipes are not bedded on concrete, the floor shall be left slightly high and carefully placed so that the pipe barrels rest on undisturbed ground. If anywhere the excavation has been carried too low packing shall be done in concrete. Where laid on rock or very hard ground which cannot be easily excavated to a smooth surface, the pipes shall be laid on a cradle of fine concrete floor of gravel and crushed stone over laid with concrete or on a well consolidated gravel and crushed stone bed as desired by the Engineer. PVC or similar pipes shall be laid directly on stable soil and packed with selected soil.

The minimum support and protection for glazed stoneware pipes shall be as follows:

i. When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely.

ii. Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the wewer shall be bedded on concrete.

iii. Where the pipes have to be laid on soft soil with the maximum water table rising above the invert of the pipe, but below the top of the barrel, the pipe sewer shall be haunched.

iv. Where maximum water table is likely to rise above the top of the barrel or wherever the pipe is laid on soft soil the pipe sewers shall be completely encased or surrounded with concrete.

Vitrified clay pipes shall be laid on a bed of 150mm thick cement concrete (1:3:6) nominal mix by volume.

Cast iron pipes and concrete pipes may be supported on suitable concrete or brick support, where specified. The supports shall be unyielding and strong enough. At least one support shall be located close to ends. Spacing of intermediate supports shall be as decided by the Engineer. Pipes shall be secured to the supports by approved means.

Anchoring of pipes where necessary shall be achieved by suitable concrete encasing designed for the expected thrust.

**d. Entry *into Structures***

For entry of the pipe lines into any building of structure suitable conduits under the structure or sleeves shall be used. The conduits and sleeves shall be such as to allow easy repairs and replacement of the pipes. When openings or chases are required to be made in the structure for entry of pipe lines, locations and sizes shall be marked and checked by the Engineer. After laying of the pipeline the openings and chases shall be mended.

**e. *Ducts***

Where solid, waste and ventilating pipes are accommodated in ducts, access to cleaning areas shall be provided. Connection to drain shall be through a gully with sealed cover to guard against ingress of sewer gas, vermin or backflow.

**f. *Traps and Ventilating Pipes***

Pipes are carrying off the waste, from water closets and waste water and overflow water from baths, wash basins, sinks to drains shall be trapped immediately beneath such fixtures. Traps shall have minimum water seal of 50mm and shall be ventilated whenever such ventilation is necessary to maintain water seal of the trap.

Ventilating pipes shall be carried up vertically from the drain to a height of at least 600 mm above the outer covering of the roof of the building or as shown on drawings. All vertical ventilating, anti-syphonage and similar pipe shall be covered on top with a cowl. The cowl shall be made of CI unless desired otherwise by the Engineer.

**g. *Manhole and Inspection Chambers***

The maximum distance between manholes shall be 30 meter unless specially 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 metres unless desired otherwise. Manhole

shall be constructed so as to be watertight under test. The bending at the sides shall be carried out in such a manner as to provide no lodgement for any splashing in case of accidental flashing of the chamber. 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.

Connecting to existing sewer lines shall be through a manhole.

Manholes shall be provided with standard C.I covers. The covers shall be close fittings so as to prevent gases from coming out. Suitable heavy duty covers shall be used where necessary as decided by the Engineer.

**h.** ***Cutting of Pipes***

Manufacturer's instructions shall be followed for cutting of pipes where necessary. Suitable and approved tools shall be used for the cutting so as to leave surface clean and square to the axis of the pipe.

**i.** ***Jointing***

Jointing of laid pipes shall be so planned as to avoid completely any movement or strain to the joints already made. If any joint is suspected to be damaged it shall be opened out and redone.

All joints between pipes, pipes and fittings and manholes shall be gas tight when above ground and water tight when underground. Method of jointing shall be as per instruction of the pipe and fittings manufacturer and as approved by the Engineer. However, in the absence of any instruction available from the manufacturer the methods as detailed hereunder shall be used.

i. *Cast Iron Pipe*

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centred in the socket of the next pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. When the gasket or hemp yarn has been caulked tightly a jointing shall be placed round the barrel and tightened against the face of the socket to prevent airlock. Molten lead shall then be poured in to fill the remainder of the socket and caulked with suitable tools right round the joint to make up for shrinkage of the molten metal on cooling and shall be finished 3mm behind the socket face.

ii. *Concrete Pipes*

Care shall be taken to place the collar centrally over the joint.

*iii. Glazed Stoneware*

Tarred gasket or hemp yarn *Pipes* soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be placed into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly so as not to fill more than ¼ of the total depth of the socket. The remainder of the socket shall be filled with a stiff mixture of cement mortar of 1:1 proportion. Then the socket is filled, a fillet shall be formed round the joint with a trowel, forming an angle of 45 deg. With the barrel of the pipe. The newly made joints shall be protected, until set and shall be covered with damp cloth or other suitable materials.

3.06 **Trenches and Other Excavations**

Width of the trench at the bottom shall be such as to provide 200mm clearance on either side of the pipe for facility of laying and jointing.

Excavated material shall be stacked sufficiently away from the edge of the trench and the side of the spoil bank shall not be allowed to endanger the stability of the excavation. Spoil may be carted away and used for filling the trench.

Turf, top soil or other surface material shall be set aside, turf being carefully rolled and stacked for use in reinstatement.

All excavation shall be properly timbered, where necessary,

Efficient arrangements for dewatering during excavation and keeping it dry till backfilling shall be made to the satisfaction of the Engineer. Sumps for dewatering shall be located away from the pipe layout. Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Where the excavation proceeds through roads necessary permissions shall be secured by the Contractors from the appropriate authorities.

Special care shall be taken not to damage underground services, cables etc. These when exposed shall be kept adequately supported till the trench is backfilled.

The backfilling shall be done only after the pipeline has been tested and approved by the Engineer. Special care shall be taken under and sides of the pipe during hand packing with selected material. At least 300mm over the pipe shall also be filled with soft earth or sand consolidation shall be done 150mm layers. The surface water shall be prevented from getting into the filled up trench. Traffic shall not be inconvenienced by heaping up unduly the backfilling material to compensate future settlement. All future settlements shall be made good regularly to minimise inconvenience of traffic where applicable.

4.00 **Fixtures**

4.01 The Tenderer shall mention in his bid the type and make of the fixtures he intends to use enclosing manufacturers current catalogues. In the absence of any such agreement, the Engineer shall be at liberty to choose any type and make.

4.02 All fixtures and fittings shall be of approved quality and type manufactured by well known manufacturers. All items brought to the site must bear identification marks of the type of the manufacturer. Procurements shall be made well in advance and inspected and approved immediately by the Engineer. All fixtures shall be adequately protected, covered and plugged till handed over.

4.03 All fittings, gratings, fasteners, unless specified otherwise shall be chromium plated. The connecting lead pipes and bends shall weigh at least 3kg per 25mm dia per meter length. Where PVC or similar pipes are allowed the Contractor shall produce the test report and convince the Engineer about their durability.

5.00 **SEPTIC TANK & EFFLUENT DISPOSAL**

a. ***Septic Tank***

Septic tank shall consist of the tank with inlet and outlets complete with all necessary earthwork and backfilling. The details of septic tank shall be as shown on drawings. This items shall also include ventilating pipe of at least 100mm dia whose top shall be provided with a suitable mosquito proof wire mesh and cowl. Ventilating pipe shall extend to a height of about 2 meter when the septic tank is at least 15 meter away from the nearest building and to a height 2 meter above the top of building when it is located closer than 15 meter. Ventilating pipes can be connected to the normal soil ventilating system of the building where allowed.

b. **Effluent Disposal**

The effluent from the septic tank shall be disposed.

c. **Soak Pit**

The soak pit shall be complete as shown on drawing. It shall consist of a 900 mm dia pit 1000 mm in depth below the invert level of the inlet pipe. The pit shall be lined with stone, brick or concrete blocks set in cement mortar (1:6) and filled with brick bats. Inlet pipe shall be taken down to a depth 900 mm from the top as an anti-mosquito measure.

d. **Open Jointed SW Pipe/Dispersion Trenches**

Minimum dia of the SW pipes shall be 150mm nominal. The trench for laying the pipes shall be minimum 600x600mm. The joints of the pipes shall be left unsealed. The entire length of the pipe within the trench shall be buried in a 250mm layer gravel or crushed stone of uniform size. On top of gravel / crushed stone a layer of 150mm bed of well graded coarse aggregate shall be laid. Ordinary soil is used for filling the top of trench.

e. **Commissioning Septic Tank.**

After the septic tank has been proved watertight and the sewage system is checked the tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall be seeded with well digested sludge obtained from septic tank or sludge digestion tank. In the absence of digested sludge a small quantity of decaying organic matter such as digested cow-dung may be introduced.

## 6.00 OVER HEAD WATER STORAGE TANKS

**RCC Tank**

Unless otherwise mentioned water storage tanks for toilets shall be reinforced cement concrete tanks of adequate size and capacity. M-20 grade concrete shall be used for construction of tank and shall be designed as 'uncracked' section as per IS:3370. Water proofing admixture shall be added as required. The outlet pipe shall be 50 mm above the bottom of the tank and there shall be 150 mm free board at the top of the tank. Overflow vent pipe shall be provided.

All tanks shall be supplied with mosquito proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 m shall be provided with MS internal access ladder adjacent to the manhole. Water level indicator shall be provided.

**Polyethylene water tank**

PVC tanks shall meet the requirements IS:12701. Virgin HDPE granules of approval

grade, suitable for drinking water shall be used for making the tank. Carbon black shall be added with the granules. Tanks shall be single piece, seamless construction, mouldd by rotational moulding. Shape of tank shall be cylindrical – vertical type with corrugation along the length and bottom of the tank. Tank shall have closed top provided with lid. However, for storage inside, the rectangular loft tank of approved colour shall be provided.

Tank shall be provided with all fittings for inlet, overflow, outlet pipes and ball valves including mosquito proof coupling.

Tank shall be leak proof. Tank shall be installed with proper support and anchorage for installation and it shall be carried out according to the recommendation of clause No. 13 of IS:12701 – 1989.

## 7.00 TESTING OF PIPELINES FOR DRAINAGE & SANITATION

Comprehensive test of all pipe lines shall be made by simulating conditions of use. The method of actual test shall be decided by the Engineer. All test date shall be recorded and submitted to the Engineer for review and instruction. The Engineer's discretion regarding tolerance shall be final.

General guidance for the test are given below:-

**Smoke Test**

All soil pipes, waste pipes, vent pipes & all other pipes when above ground shall be approved gas tight by a smoke test conducted under a pressure of 25mm of water and maintained for 15 minutes after all rap seals have been filled with water. The smoke is produced by burning oily waste or tar paper of similar material in the combustion chamber of a smoke machine. Chemical smoke is not satisfactory.

**For Straightness**

It shall be checked by inserting at the high end of the sewer or drain a smooth ball of a diameter 1.3 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball will roll down the invert of the pipe and emerge at the lower end; and

By means of mirror at one end of the line and lamp at the other end. If the pipeline is straight, the full circle of light may be observed. The mirror will also indicate obstruction in the barrel if the pipeline is not straight.

Testing of Water Mains after Laying

After laying and jointing, the main shall be slowly and carefully charged with water, so that all air is expelled from the main, by providing 25mm inlet with a stop-cock, allowed to stand full of water for a few days if time permits, and then tested under pressure. The test pressure shall be 5KG/sqc. or double the maximum working pressure, whichever is greater. The pressure shall be

applied by means of a manually operated test pump, or in the case of long mains or mains of a large diameter by a power driven test pump provided that the pump is not left unattended. In either case due precaution shall be taken to ensure that the required test pressure is not exceeded. Pressure gauges shall be accurate and shall preferably have been recalibrated before the test. The pump having been stopped, the test pressure shall maintain itself without measurable loss for at least five minutes. The end of the mains shall be closed by fitting a watertight expanding plug and plug shall be secured by struts to resist end thrust of the water pressure in the mains.

Testing of Service Pipes and Fittings

The service pipes shall be slowly and carefully charged with water allowing all air to escape avoiding all shock or water hammer.

**Fixture etc.**

All fixture and fittings shall be connected by Water tight joints. No dripping shall be accepted.

8.00 TESTING AND ACCEPTANCE

All pipes, fittings and fixtures shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes shall again be inspected on site before laying by sounding to disclose cracks. All defective items shall be clearly marked and forthwith removed from the site.

**9.00 Measurement**

( Applicable for “Item Rate” contracts only )

This shall be calculated by the number of appliances the price being intended to cover supply and installation including any required hardware, and accessories. All G.I, castiron and stone ware pipes required for water supply and disposal to septic tank etc. shall be paid for separately.

## 10.00 APPLICABLE CODES AND SPECIFICATIONS

The following codes, standards and specifications are made a part of this specification. All standards, tentative specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions.

**Pipes & Sanitary Applications**

IS:1536-1989 : Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.

IS:1626 : Specification for asbestos cement building pipes and pipe fitting, gutters and gutter fittings (spigot and socket types)

IS:1726-1991 : Specification for cast iron manhole covers and frames.

IS:1703-1989 : Specification for copper alloy float valves (horizontal plunger type)including water supply fittings.

IS:1729-1979 : Sand cast iron spigot and socket, soil waste and ventilating pipes, fittings and accessories.

IS:2526 : Vitreous sanitary appliances (Part I to XV)

IS:2963-1979 : Specification for copper alloy waste fittings for wash basins and sinks.

IS:3311-1979 : Specification for waste plug and its accessories for sinks and wash basins.

IS:5329-1983 : Code of practice for sanitary pipe work above ground for buildings.

IS:5434-1969 : Specification for non-ferrous alloy bottle traps for marine use.

IS:3006-1979 : Specification for chemically resistant glazed stoneware pipes and fittings.

IS:1172 : Code of Basic Requirements for Water Supply, Drainage and Sanitation.

IS:1200 (Part –XVI) : Laying of Water and Sewer Lines Including Appurtenant Items.

IS:1239 (Part 1&ii) : Mild Steel Tubes and Mild Steel Tubular and other wrought Steel pipe fittings

IS:1537 : Vertically Cast Iron Pressure Pipes for Water, Gas and Sewage

IS:3486 : Vertically cast iron pressure pipe for water, gas & sewage

IS:1742 : Code of Practice for Building Drainage

IS:2470 : Code of Practice for designs and construction of septic tanks for small and large installations.

IS:3076 Low density polyethylene pipes for potable water supplies.

IS:4984: High density polyethylene pipes for potable water supplies.

IS:1538 Cast Iron fittings for pressure pipes for water, Gas and sewage

IS:1230 : Cast Iron rain water pipes and fittings.

IS:3889 Centrifugally cast(spun) iron spigot & soil waste and ventilating pipes, fittings and accessories.

IS:458 : Concrete pipes (with and without reinforcment)

IS:783 : Code of Practice for laying of concrete pipes.

IS:784 : Pre stressed concrete pipes.

IS:651 : Salt glazed, stoneware pipes & fittings.

IS:4127 : Code of practice for laying of glazed stoneware pipes.

IS:5961 : Cast Iron gratings for drainage purposes.

IS:5219 (Part 1) : 'P & S' traps.

IS:771 : Glazed earthen-ware sanitary appliance.

IS:772 : General requirements of enamelled cast iron Sanitary appliances.

IS:774 : Flushing cistern for water closets & urinals (valve less siphonic type.)

IS:775 : cast Iron brackets & supports for wash basins and sinks.

IS:2548 : Plastic water closet seats & covers.

IS:2527 Code of practice for fixing rain water gutters and down pipes roof drainage.

**Annexure-5**
**STANDARD TECHNICAL SPECIFICATIONS FOR CAST-IN-SITU RCC PILES**

CONTENTS:



1.00 **GENERAL**

1.01 The work covered under this specification is installation of cast-in-situ driven friction cum end bearing piles or bored cast-in-situ friction cum end bearing piles and construction of pile caps, grade beams and pedestals conforming to the relevant Indian Standards and as detailed below:

1.02 **Line and Levels**

The Contractor shall establish and locate all lines and levels & shall be responsible for the correct location of all piles.

1.03 All tenderers shall furnish information about the type of piles they specialized in, which shall be submitted along with the bid.

1.04 The diameter and type of pile and the method of piling shall be given to the Contractor. The detailed calculations, assumptions etc. in arriving at the standard depth shall be submitted by the contractor based on the set criteria.

1.05 In any case, the actual design shall be established after trial pile has been tested and results compared with the analytical design. The acceptance of the design calculations does not relieve the contractor from the responsibility of adequacy of piles to carry the design loads.

1.06 The piles shall be founded on suitable and continuous strata.

1.07 Location of Piles: A plan in triplicate, showing clearly the designation of piles to be installed by an identifying system shall be given to the Contractor before the installation of piling is started. The Contractor has to execute the piling work as per the detailed design drawing .

1.08 **Obstructions:-**

Where boulders or other obstructions make it impossible to drive/bore certain pile in the location shown and to the proper bearing strata, the Contractor shall resort to all usual methods to install piles as required, including studding, jetting or other feasible means.

1.09 A record of pile driving/boring shall be kept by the Contractor in an approved format. The Contractor shall furnish signed typewritten copies of the recorded data to the Engineer-in-Charge. The record shall give the diameter, length, location, type, calculated safe load, penetration under the last five blows of hammer if any and the result of any tests. Any deviation from the designed location, alignment or load carrying capacity or any upheaval noticed on any pile during installation shall be immediately reported to the Engineer-in-charge and adequate corrective measures shall be taken as, decided by the Engineer-in-charge at the cost of the Contractor. On the completion of pile installation, pile driving records together with the records of such additional borings or other information that were obtained during the installation of pile shall also be filed by the Contractor with the Engineer in charge in triplicate.

1.10 The cut-off levels for piles shall be as shown in the construction drawings. The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment in to the pile cap. No extra payment will be made for the length from existing ground level to cut off level. The rates for piling work shall include the cost of breaking of concrete in pile above the cut-off level and removal of debris etc. resulting from cutting off of piles for constructing the pile cap. However, the length of pile for purpose of payment shall be considered from bottom of the shoe (of pile) to cut-off level only.

1.11 **Layout**

The complete laying and setting out of work required for piling shall be done by the Contractor at his own cost. The Contractor at his own cost shall build and preserve benchmarks constructed with reference to the permanent benchmark and Reference pillars indicated by the Engineer. He shall give all help with accurate survey instruments including Theodolite of high quality, and other test equipment, materials and men to the Engineer for checking the detailed layout and levels. The contractor shall be solely responsible for correctness of layout and levels. The checking and approval of the engineer will not absolve the contractor from his responsibility of carrying out the work at correct locations and levels.

## 2.00 MATERIALS

### 2.01 Grade of Concrete

2.01.01 Concrete mix for piles shall be of grade M-25 **with minimum cement content as 400 kg/m3**. Concrete Mix and Tests shall conform to Clause 10.0 Section B3 of this specification.

2.02 **Reinforcement**

2.02.01 Reinforcement to be used shall be TMT/TOR steel bars conforming to latest IS codes and plain mild steel bars conforming to IS:2062 (Part-I) (latest) and shall conform to specifications for Reinforcement Steel mentioned in Clause 5.0, Section B3 of this specification.

2.02.02 The longitudinal reinforcement (Main Steel) shall not be less than 0.4% of the cross sectional area of the pile and diameter of the longitudinal bars shall not be less than 12mm. Minimum number of longitudinal reinforcement bars shall be six. The dia of the lateral reinforcement shall be 8 mm and provided for the entire length of the pile. The longitudinal bars shall project above pile cut off level to have adequate bond length inside pile cap. Laps in reinforcement bars shall be staggered.

2.03 **Cement**

2.03.01 Cement shall be Ordinary Portland Cement grade 43, unless otherwise specified, conforming to IS:8112 of the recent manufacture and shall conform to the specifications. This shall conform to clause 1.01 of Section B3 of this Specification.

2.03.02 Cement of different brands/batches shall be stored separately and consumed in works in the same order as supply unless otherwise directed.

2.04 **Aggregates**

2.04.01 All coarse and fine aggregates shall conform to the Clause No. 1.02, Section B3 of this specifications. Graded coarse aggregates of size 20mm and down shall be used.

2.05 **Placing Reinforcement**

2.05.01 Reinforcement as required shall be made into stiff cages sufficiently wired with 2 strands of 16 gauge annealed soft iron binding wire (Galvanized) welded to withstand handling without any damage or distortion. Reinforcement shall be placed after piling tubes are installed properly and it is ensured that no water has percolated from out side. The reinforcement should be supported away from the sides of the shaft by means of suitable space block to ensure concentric alignment in the shaft. Steps shall be taken to ensure correct

positioning during concreting of reinforcement in the piles without any distortion.

2.05.02 Nominal lap between reinforcement cages shall be minimum 600mm and the main reinforcing steel shall project for a length of 50 times the diameter of the reinforcement bar, sufficient to develop bond above the level of the under side of the pile cap. The nominal cover to outermost reinforcement shall be not less than 50mm and suitable spacer blocks shall be provided in intervals not exceeding two (2) meters and wired to the main reinforcement. In addition to binding with the wire after giving laps the reinforcement shall also be tack welded at certain intervals as approved by the Engineer in charge.

2.05.03 The longitudinal bars shall project above pile cut-off level to have adequate bond length inside pile cap. To protect the exposed reinforcement of the piles, cement slurry coat as approved by the Engineer shall be provided at no extra cost.

2.05.04 In case the reinforcing cage is made up of more than one segment, these shall be assembled before being lowered by providing necessary lap and also intermittent welding. Care shall be taken for welding of Tor steel using proper electrodes.

2.06 **Placing of Concrete**

2.06.01 Before placement of concrete care shall be taken to ensure that the inside of the casing is free from sludge or any foreign matter. Concreting may be permitted if the water level inside is 150mm above the inner surface of shoe and no additional percolation is there. Water cement ratio is to be restricted to 0.45 to 0.50 maximum. Slump should be restricted between 150mm to 175mm. For this, if needed plasticizer is to be used.

2.06.02 The concrete shall be placed by tremie method in such a way that it fills the entire volume of the casing without the formation of voids caused by entrapped air and is properly compacted. The volume of concrete placed shall be observed in the case of few piles initially cast and the average figure obtained shall be used to check, whether there is undue deviations in the volume of concrete placed for the subsequent piles.

2.06.03 The top of concrete in a pile shall be brought above the cut-off level as per Cl. 7.8 of IS:2911 (part1/sec2). The balance portion shall be concreted with lean concrete of grade M10 with 40mm down aggregate.

2.06.04 Withdrawal of casing (if used) shall be carried out with utmost care. It shall be ensured that the level of concrete in the casing is usually two meter above the bottom level of casing at any time.

2.06.05 Since supervision at night becomes difficult concreting shall be carried out only from morning to evening on two shifts basis. However, driving may be permitted round the clock. The contractor shall bring such

number of rigs considered by him adequate to complete a minimum of 750 piles per month.

2.07. **Load Test on Piles**

Load test on piles shall be carried out to check the bearing capacity of piles in the manner as follows:-

2.07.01 Load test shall be conducted as per IS:2911 (Part-IV). However the method of testing and maximum test load as specified else where in the specification.

2.07.02 The observation and recording of settlements and rebound shall be done by the contractor in the presence of Engineer's representative.Three copies of all the readings for the test shall be supplied by the Contractor to the Engineer. Recording of the observations shall be in the Performa enclosed with this specification. The pile load test shall be carried out only after four weeks of casting of the pile.

2.07.03 Prior to the commencement of piling, initial trial test piles shall be constructed and tested for vertical (compression), pullout and lateral load capacities. Number of tests shall be conducted as per the directions and to the satisfaction of the Engineer. However for each size, minimum two piles are required to be tested for each type of test.

2.07.04 In addition to the initial tests, routine tests for vertical load capacity and lateral load capacity shall be carried out on the working piles as per the direction of the Engineer/Consultant. Number of such routine tests shall be minimum of one percent (1%) of the total number of piles or as directed by engineer.

**2.07.05 Routine Load Test on Working Piles**

**2.07.05.1** These tests shall be carried out on working piles by maintained load method up to one and half times the working load and the maximum settlement of test loading in position being not exceeding 12 mm as per IS2911 (Part - IV).
These tests shall be done for :

a. Vertical load

b. Lateral load

2.07.05.2 In case a pile fails under or during the load test, the Engineer shall select two additional piles in lieu of each of such failed pile and the Contractor shall carry out load tests on such additional piles at his own cost.

2.07.06 **Initial Pile Load Test on Test Piles**

The initial pile load tests shall be conducted as per IS:2911 (Part-IV) to assess the capacity of the pile and to fix a more accurate driving criteria viz set/blow, total number of blows and approximate depth etc. of founding level. The initial pile load tests shall be conducted on test piles installed for this purpose. These tests shall be done for

a) Vertical (Compression) Load

Initial load test for safe vertical compression load is to be done by Cyclic load method (as per IS:2911 (Part 4)-1985). This test shall be carried out up to a maximum of 3 times the safe load.

b) Lateral Load

Lateral load test shall be carried out as per IS:2911 (Part 4) 1985. This test shall be continued up to a maximum test load of 3 times the safe load.

c) Pull out load

Pullout test requirements shall be as per clause 8 of IS.2911 (Part 4) 1985. This test shall be continued up to a maximum test load of 3 times the safe load .

2.08 Deleted

2.09 Deleted

2.10 Deleted

2.11 Deleted

2.12 **Load Test Arrangement**

2.12.01 The Contractor shall arrange at his own cost sufficient amount of kentledge for loading well in advance of the commencement of the load test. The kentledge/reaction provided shall be at least 25% more than the load at which the piles are to be tested. Detailed proposal together with a sketch for the load test arrangement shall be furnished by the Contractor to the Engineer for the later's checking and approval. Detailed pile testing records and results including all information shall be submitted in triplicate by the Contractor to Engineer for approval.

2.12.02 Jacks used in any particular load test should be of the same capacity and their number shall be limited to two only. They should preferably be connected and

operated by one pump. The contractor shall submit certificates certifying the correctness of the calibrations of the pressure gauges and jacks before use. All jacks should be fitted with locking devices. Settlement and rebound shall be recorded by four (4) dial gauges having sensitivity of 0.01 mm and also by other independent means of direct measurement. Dial gauges shall be supported independently and in such a way as to be not affected by the settlement of the piles.

2.12.03 During the actual testing of test piles, the Contractor's plant and personnel may remain temporarily idle. Again, during the period of redesign, if any (based on the pile test results), the plant and personnel of the Contractor may remain idle during the period of construction. For such idle periods mentioned above, the contractor will not be entitled to any claim and rates quoted by him shall include the same. However, during testing of piles and other holdups wherever possible and in case when load tests are not completed, pile construction may be allowed in flexible pattern as approved by the Engineer.

## 2.13 Accepted Standards

2.13.01 The piles shall be accepted as satisfactory only when the work has been executed in accordance with this specification and IS Codes to the satisfaction of the Engineer and the following conditions are met: -

a) **Permissible Tolerances**

The head of the pile shall be within 75mm of the specified plan position on the drawings and the pile shall not be out of plumb by more than one and a half percent. The toe of the pile shall be at the approved bearing level in each case. Any pile deviating from these limits shall be replaced or supplemented by an additional pile by contractor at no extra cost to owner. No forcible correction shall be made to piles once that are installed.

b) **Casing of Piles**

The casing, reinforcement cage, concrete mix, placing consolidation and curing shall be strictly as per the specification. The concrete shall show the specified strength as indicated by the cube test results.

c) **Load Tests**

The result of the load tests carried out in accordance with the specifications and IS Codes for load test shall be as described above.

## 2.14 Defective Piles

2.14.01 If an individual pile should fail to meet the requirements specified in clauses 2.07 above such piles may be deemed to be defective and the Engineer may order such investigation to be made as he considers appropriate.

2.14.02 Any pile which is shown to be defective under the load test shall not be accepted and the Engineer will relate such failure to the acceptance of other piles in the area.

2.14.03 When any piles is found defective, the Contractor shall perform at his own expense one or more of the following remedial measures as directed by the Engineer:-

a) Replacement of defective piles

b) Providing additional piles

## 3.00 DRIVEN CAST-IN-SITU PILING

3.01 This specification deals with the requirements of materials, workmanship and installation of cast-in-situ driven reinforced concrete piles. The materials and workmanship shall conform with the specification, the provision of the following latest Indian Standard Codes in particular and such other standard as mentioned elsewhere in the specification.

i. IS:456-2000 : Code of Practice for Plain and Reinforcement Concrete

ii. IS:2911 (Part-I) Section I : Code of Practice for Design and Construction of Pile Foundation (Driven Cast-in-Situ)

iii. IS:2911 (Part-IV) : Load Test on Piles

3.02 The specification does not cover minute details and the work shall be executed according to the specifications and in the absence of the latter, the work shall be carried out according to the best prevailing practices and to the recommendations of Indian, American, British Standard Institutions at the discretion of the Engineer.

3.03 The Contractor shall design the piles based on the soil investigation report and data available with the Owner and data collected by the bidder at Site. However, the minimum factor of safety shall be 2.5.

3.04 The information provided herein for the bidders are for guidance only. The Owner/Consultant does not guarantee the reliability or accuracy of the data and does not assume any responsibility whatsoever for any variations, conclusions or interpretations that might be made there from.

3.05 Care shall be taken while driving piles that no existing foundation and sub-structures are disturbed by providing suitable arrangement like shoring etc.

3.06 **PILING**

3.06.01 **Sequence of Piling**

The sequence of piles to be installed shall be such that the adjacent piles already installed are not disturbed nor their carrying capacity reduced by subsequent driving or boring operation. In a group the installation of the piles shall normally proceed from the center of the group towards the periphery. The Contractor shall submit the sequence order and construction schedule to the Engineer and get his approval before the commencement of work.

3.06.02 These piles shall be installed by driving a temporary steel casing with detachable shoe into the ground up to the specified depth. To cushion against impact, standard steel helmets shall be provided and fitted to the casing. Driving shall be performed using leaders to fix casing in position and maintain axial alignment of hammer and casing. Pile drivers shall have supporting leads up to the lowest point the hammer can reach. The shift in position shall be subject to tolerances specified in IS Code.

3.06.03 The shoes shall preferably be of double collar of MS type. In case double collar fabricated shoes are used, the same shall be painted with one coat of bituminous Paint. Details of shoes shall be got approved by Engineer/Consultant before commencement of work.

3.06.04 Casings may be driven by drop, single or double acting, differential or diesel hammers. When driving casings to final set these hammers shall be driven at full rated energy required. Temporary compression on the casings as per IS:2911 shall be taken into account. Casing shall be driven continuously to final elevation or specified resistance. If the driving is interrupted due to unavoidable circumstances then it should be driven to the final elevation of adjacent casings driven uninterrupted.

3.06.05 Set calculation will be furnished separately.

3.06.06 Tenderer shall furnish information regarding pile driving method, equipment details, formula or data curves etc.

3.06.07 A record of sudden changes in the rate of penetration not attributable to solid strata shall be maintained and brought to the notice of the Engineer-in-Charge immediately on occurrence before resuming further operation.

3.06.08 Piling shall be carried out from existing ground level itself and as per the directions of the Engineer and approved drawings.

3.07 **Data Recording**

The Contractor shall maintain a register signed jointly by Contractor/Engineer, giving the information for each pile in the Performa appended to this Annexure.

4.00 **BORED CAST-IN-SITU PILING**

The specification deals with the requirements of materials, workmanship and installation of Bored Cast-in-situ reinforced concrete piles.

The materials and workmanship shall conform with the specification, the provision of the following latest Indian Standard Codes in Particular and such other standard as mentioned elsewhere in the specification:

| | | | |
|---|---|---|---|
| i. | IS:456-2000 | : | Code of Practice for Plain and Reinforced Concrete |
| ii. | IS:2911 (Part-I) Section II | : | Code of Practice for Design and Construction of Pile Foundations (Bored Cast-in-Situ). |
| iii. | IS:2911 Part-IV | : | Load Test on Piles |

4.01 The Contractor shall design the piles based on the soil investigation report, data available with the Owner and data collected by the Bidder at site. However, the minimum factor of safety shall be 2.5.

4.02 Care shall be taken while boring and constructing piles and pile cap that no existing foundations/sub-structures are disturbed by providing suitable arrangements like shoring etc.

4.03 **Piling**

4.03.01 **Sequence of Piling**

The sequence of piles to be installed shall be such that the adjacent piles already installed are not disturbed nor their carrying capacity reduced by subsequent boring operation. In a group the installation of the piles shall normally proceed from the center of the group towards the periphery. The Contractor shall submit the sequence order and construction schedule to the Engineer and get his approval before the commencement of work.

4.03.02 **Control of Alignment**

Piles shall be installed as accurately as possible as per the designs and drawings either vertically or to the specified batter. Greater care should be exercised in respect of installation of single pile or piles in two pile group. For vertical piles a deviation of 1.5 percent should not normally be exceeded. Piles should not deviate more than 75mm or D/10 whichever is more in case of piles having diameter more than 600mm from their designed positions at the working level of the piling rig. In the case of a single pile in a column positional tolerance should not be more than 50mm (100mm in case of piles having diameter more than 600mm)

4.03.03 For piles carried to substantial depth, the design should provide for the worst combination of the above tolerance in position and inclination. In case of piles deviating beyond these limits and to such an extent that the resulting eccentricity cannot be taken care of by a redesign of the pile cap and ties, the piles shall be replaced or supplemented by one or more additional piles, as directed by the Engineer, at no extra cost to the Owner.

4.03.04 Any deviation from the designed location, alignment or load capacity or any pile shall be noted and brought to the attention of the Engineer and rectification and supplemental works carried out to the satisfaction of the Engineer at no extra cost.

4.03.05 A minimum length of one meter of temporary casing shall be inserted in each bored pile unless otherwise specifically desired. Additional length of temporary casing may be used depending on the condition of the strata etc.

4.03.06 Drilling mud of suitable consistency may also be used instead of temporary casings for stabilizing sides of the holes.

4.03.07 In case, a bore hole is stabilized by drilling mud the bottom of the hole shall be cleaned very carefully before concreting work is taken upon. The cleaning of the hole be ensured by careful operation of boring tool and/or flushing of the drilling mud through the bottom of the hole. Flushing of bore holes before concreting with fresh drilling fluid/mud is preferred.

4.03.08 In case a hole is bored by use of drilling mud, the specific gravity of the mud suspension near about the bottom of the hole shall, whenever practicable, be determined by suitable slurry sampler and at suitable interval of piles and recorded. Consistency of the drilling mud suspension shall be controlled throughout the boring as well as concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with the thicker suspension of the mud.

4.03.09 The concreting operations should not be taken up when the specific gravity of bottom slurry is more than 1.2. Concreting shall be done by tremie method in all such cases.

4.03.10 Deleted

4.03.11 In case, defective piles are formed, they shall be removed or left in place if so directed by the Engineer if these do not affect the performance of the adjacent piles or the cap as a whole. Additional piles shall be provided to replace them as directed by the Engineer.

4.03.12 Any deviation from the designed location alignment or load capacity of any pile shall be noted and adequate measures taken well before the concreting, of the pile cap and plinth beam if the deviations are beyond the permissible limit.

4.03.13 During chipping of the pile top manual chipping may be permitted after three days of pile casting, pneumatic tools for chipping shall not be used before seven days after pile casting.

4.03.14 After concreting, the actual quantity of concrete shall be compared with the average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

4.03.15 The bentonite suspension used for piling work shall satisfy the following requirements:

a) The liquid limit of bentonite when tested in accordance with IS:2720 (Part V) shall be more than 300 percent and less than 450 percent.

b) The sand content of the bentonite powder shall not be greater than 7 percent.

c) Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the freshly prepared bentonite suspension shall be between 1.034 and 1.10 gm/ml depending upon the pile dimensions and type of soil in which piling is to be done. However the density of Bentonite suspension after mixing with deleterious materials in the bore holes may be up to 1.25 gm/ml.

d) The Marsh viscosity when tested by a Marsh cone shall be between 30 to 60 seconds.

e) The differential free swell shall be more than 540%.

f) The PH value shall be between 9 and 11.5.

4.04 **Data Recording**

The Contractor shall maintain register signed jointly by the Contractor/Engineer, giving the information for each pile in the approved Performa.

**ANNEXURE - A**

PILE INSTALLATION RECORDS

Pile No. :
Date of Piling :

Pile type : Driven/Bored cast-in-situ

Pile Dia : Pile capacity :

Location of Pile …… Date and time of driving/boring ……

Date of casting ……

Concrete mix …… Test Cube Results ……..

Nature of founding Strata ……

Elevation of Ground …… Elevation of Cut off level ……

Standing ground water level ……..

Reinforcement Details ……..

Any interruptions in the work (if so the details shall be furnished) Yes/No

**DRIVEN PILES**

Type of Hammer ……

Weight of Hammer …… Height of Fall …….

Number of Blows during last 25mm driving
……

Set of 10 blows ……mm

Depth finally driven ……

Net length :

Total concrete quantity :

Quantity of Cement per m3 ……

Extra cement added, if any ……

## DETAILS OF PILE TEST

Pile type :

Pile No. :

Location of pile :

Pile dia :

Pile capacity :

Date of Casting :

Date of Testing :

Total blows :

Set in last 10 blow :

Elevation of Driving :

Elevation of cut-off level :

Gross length from Elev. Of driving to Bottom of Pile Shoes :

Net length :

Cement Consumed :

Reinforcement :

## DETAILS OF TESTING JACKS

Jack Ram Dia : m

Load Applied on Ram : Ton

Dial Gauge 1 Div. : mm

## DETAILS OF PILE TEST

(A) **Loading Reading**

| Date | Time | Period | Load in Tons | Deflection on load A | B | C | D | Average Reading | Gross Settle-ment(mm) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

(B) Unloading Reading

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|

[C] Loading Settlement Curve

**Annexure-6**
**STANDARD TECHNICAL SPECIFICATIONS FOR CONCRETE AND ALLIED WORKS**

## CONTENTS:

| | |
|---|---|
| 33.0 | **Inserts and Cut-outs in Concrete Works** |
| 34.0 | Water Stops |
| 35.0 | Precast concrete units |
| 36.0 | Inspection |
| 37.0 | Clean Up |
| 38.0 | Sampling, testing & quality control |
| 39.0 | CPCI and ERBP treatment |

1.00 **SCOPE**

This part of specification covers the general requirements for concrete to be used on jobs using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing and testing of concrete and also requirements in regard to the quality, storage, bending and fixing of reinforcement. This also covers the transportation of concrete from the mixer to the place of final deposit and the placing, curing, protecting, repairing and finishing of concrete.

2.00 **APPLICABLE CODES AND SPECIFICATIONS**

The following specifications, standards and codes of practice are made a part of this specification. All standards, codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as applicable on the date of opening of the Bids.

In case of discrepancy between this specification and codes/standards those referred to herein, this specification shall govern.

2.01 **Indian Standard Codes for Material and its Test**

1) IS: 269 - Specification for ordinary, rapid hardening and low Heat Portland cement.

2) IS: 455 - Specification for Portland blast furnace slag cement.

3) IS: 1489 - Specification for Portland porozzolana cement. (Part 1 & Part 2)

4) IS: 4031 - Methods of physical tests for hydraulic cement. (Part 1 to Part 15)

5) IS: 650 - Specification for standard sand for testing of cement.

6) IS: 383 - Specification for coarse and fine aggregates from Natural sources for concrete.

7) IS: 2386- Methods of test for aggregates for concrete. (Part-I to VIII)

8) IS: 516- Method of test for strength of concrete.

9) IS: 1199 - Method of sampling and analysis of concrete.

10) IS: 6909- Specification for Supersulphated Cement

11) IS:12330- Specification for Sulphate resisting Portland Cement

12) IS: 3025- Methods of sampling and test (physical and chemical) water used in industry.

13) IS: 432 - Specification for mild steel and medium (Part-I & II) tensile steel bars and hard drawn steel wire for concrete reinforcement.

14) IS: 1566 - Specification for hard drawn steel wires (Part-I) fabric for concrete reinforcement.

15) IS: 1786- Specification for high strength deformed steel bars and wires for concrete reinforcement.

16) IS: 4990- Specification for plywood for concrete shuttering Work.

17) IS: 2645- Specification for integral cement waterproofing Compounds.

18) IS: 6452 - Specification for high alumina cement for structural use.

19) IS: 8112 Specification for Grade 43 ordinary Portland cement.

2.02 **Codes For Equipment**

1) IS: 1791- Specification for batch type concrete mixers.

2) IS: 2438 - Specification for roller pan mixer.

3) IS: 2505 - Specification for concrete vibrators immersion type.

4) IS: 2506 - Specification for screed board concrete vibrators

5) IS: 2514 - Specification for concrete vibrating tables.

6) IS: 3366 - Specification for pan vibrators.

7) IS: 4656 - Specification for form vibrators for concrete.

8) IS: 2722 - Specification for portable swing weigh batchers for concrete (single and double bucket type)

9) IS: 2750 - Specification for steel scaffoldings.

2.03 **Codes of Practices**

1) IS: 456 - Code of practice for plain and reinforced Concrete.

2) IS: 3370 - Code of Practice for Concrete Structures for the Storage of Liquids.

3) IS: 2502 - Code of practice for bending and fixing of bars for concrete reinforcement.

4) IS: 2751 - Recommended practice for welding of mild steel bars used for reinforced concrete construction.

5) IS: 3558 - Code of practice for use of immersion vibrators for consolidating concrete.

6) IS: 3414 - Code of practice for design and installation of joints in buildings.

7) IS: 4014 - Code of practice for steel tubular (Part-I & II) scaffolding

8) IS: 2571 - Code of practice for laying insitu cement concrete flooring.

9) IS: 3558 - Code of practice for use of immersion vibrators for consolidating concrete.

2.04 **Codes On Construction Safety**

1) IS: 3696-- Safety code for scaffolds and ladders. (Part-I & II)

3.00 **GENERAL**

3.1 The Contractor shall furnish all labour, materials and equipment required for the construction of all concrete and associated work. All cement concrete, reinforced or plain shall conform to Indian Standard Code of Practice IS: 456-2000, with latest amendment, unless otherwise specified herein. The concrete mixes used in various civil works, including the minimum cement contents, shall be as specified in the Design Basis Report / Drawings of the respective work. The proportions of fine and coarse aggregate shall be determined in the field at the instance of the Engineer and at the cost and arrangement by the Contractor.

3.2 Minimum content of cement remaining unchanged, as specified above for each type of concrete mix, the proportion and quantities of local sand and aggregate are to be worked out and determined in the field/laboratory and tested for design strength. Any change in the source of aggregates will require the re-designing of the concrete mix for Engineer's approval.

3.3 Minimum member thickness of underground walls / rafts of basements / tunnels, unless otherwise specified elsewhere, shall be as follows:

Wall of depth from 0 - 5m: 200 mm
Wall of depth from 5 – 10m: 400 mm
Wall of depth from 10 – 15m: 600 mm
Base slab of underground basement, tunnel: 600 mm

3.4 The Engineer shall have the right to inspect the source of materials used, its storage and order for any tests found necessary. The work shall be carried out to the Engineer's satisfaction.

4.00 **MATERIALS FOR STANDARD CONCRETE**

The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type Portland cement/ Sulphate Resistant Cement (SRC), Special cement, clean sand, natural coarse aggregate, clean water, and admixtures.

4.01 **Cement**

4.01.01 Cement Grade 43 shall conform to IS: 8112. Cement shall be ordinary Portland cement and/or Sulphate Resistant Cement (SRC) in 50 Kg. bags. The use of bulk cement will be permitted only with the approval of Engineer.

Changing of brands or type of cement within the same structure or portions there of shall be permitted only with the approval of Engineer.

Different type of cement shall not be mixed together. In case more than one type of cement is used in any work, a record shall be kept showing the location and the types of cement used.

4.01.02 Contractor will have to make his own arrangements for the storage of adequate quantity of cement. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulins will not be permitted) well away from the outer walls (at least 450mm away) and insulated from the floor to avoid contact with moisture from ground and stacking shall be done about 150 mm to 200mm clear above the floor using wooden planks and in a row of two bags leaving at least 600mm space to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the Site. The storage bins and storage arrangements shall be such that there is no dead storage. Not more than ten (10) bags shall be stacked in any tier to avoid lumping of cement under pressure. The storage arrangement shall be approved by Engineer. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery.

4.01.03 **Special Test Requirement**

Cement will be sampled at the work Site and tests will be made by the Contractor under the supervision of Purchaser at his expense. The Contractors will have to carry out the tests as regards conformity/suitability of cement with reference to IS: 269. Once cement is accepted by the Contractors and if the same is found to be unsuitable, all responsibility as regards unsuitability of cement with reference to IS stipulations shall be completely borne by the Contractors.

4.01.04 **Transportation of Cement**

The Contractor shall make his own arrangements for transporting the cement from Purchaser's stores, where the cement will be issued, to the work spot and for handling and storing the cement in good condition.

4.02 **REINFORCEMENT**

4.02.01 **Supply**

Reinforcement shall consist of any of the following types but shall conform to requirements shown on the drawing: -

- High Yield Strength Deformed bars Grade Fe 415 conforming to IS: 1786.

- For stirrups and / or temperature & shrinkage reinforcement plain MS bars conforming to IS: 432 (Part-I) (latest) may be used, if so Desired.

-In the event corrosion resistant steel is specified in view of the corrosive environment, any of the following reinforcement or equivalent shall be used.

1) TISCON CRS
2) SAIL –TMT – HCR-M (High Corrosion Reinforcement - Marine)

4.2.2 **Storage**

4.2.2.1 the reinforcement shall not be kept in direct contact with the ground but stacked on top of a platform made of timber sleepers or the like.

4.2.2 2 If the reinforcing rods have to be stored for a long duration, they shall be coated with cement before staking and/or be kept under cover or stored as directed by Engineer.

4.2.2.3 Fabricated reinforcement shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

4.2.3 **Quality**

4.2.3.1 All steel used shall be of Grade I quality unless specifically permitted by Engineer. No rerolled material will be accepted. If demanded by Engineer, Contractor shall submit the manufacturer's test certificate for steel. Random tests on steel supplied by Contractor may be performed by Purchaser as per relevant Indian Standards. All costs incidental to such tests shall be at Contractor's expense. Steel not conforming to specifications shall be rejected.

4.2.3.2 All reinforcement shall be clean, free from grease, oil, paint, dirt, loose mill scale, loose rust, dust, bituminous material or any other substances that will destroy or reduce the bond. All rods shall be thoroughly cleaned before being fabricated. Pitted and defective rods shall not be used. All bars shall be rigidly held in position before concreting. No welding of rods to obtain continuity shall be allowed unless approved by Engineer. If welding is approved, the work shall be carried out as per IS: 2751 according to best modern practices and as directed by Engineer. In all cases of important connections, tests shall be made to prove that the joints are of the full strength of bars welded. Special precautions, as specified by Engineer, shall be taken in the welding of cold worked reinforcing bars and bars other than mild steel.

4.2.4 **Laps**

Laps and splices for reinforcement shall be as per ARE: 456-2000. Splices in adjacent bars shall be staggered and the locations of all splices shall be approved by Engineer. The bars shall not be lapped unless the length required exceeds the maximum available lengths of bars at site.

4.2.5 **Bending**

4.2.5.1 Reinforcing bars supplied bent or in coils, shall be straightened before they are cut to size. Straightening of bars shall be done in cold and without damaging the bars. This is considered as a part of reinforcement bending fabrication work.

4.2.5.2 All bars shall be accurately bent. They shall be bent gradually by machine or other approved means. Reinforcing bars shall not be straightened and rebent in a manner that will injure the material; bars containing cracks or splits shall be rejected. They shall be bent cold, except bars of over 25 mm in diameter, which may be bent hot if specifically approved by Engineer. No reinforcement shall be bent when in position in the work without approval, whether or not it is partially embedded in hardened concrete. Bars having kinks or bends other than those required by design shall not be used.

4.2.6 **Fixing**

4.2.6.1 Reinforcement shall be accurately fixed by any approved means and maintained in the correct position by the use of blocks, spacers and chairs as per I.S. 2502 to prevent displacement during placing and compaction of concrete. Bars intended to be in contact at crossing points shall be securely bound together at all such points with 16 gauge annealed soft iron wire. The vertical distances required between successive layers of bars in beams or similar members shall be maintained by the provision of mild steel spacer bars at such intervals that the main bars do not perceptibly sag between adjacent spacer bars.

4.2.7 **Cover**

4.2.7.1 unless indicated otherwise on the drawings, clear concrete cover for reinforcement (exclusive of plaster or other decorative finish) shall be as follows:

a. At each end of reinforcing bar, not less than 25 mm nor less than twice the diameter of the bar.

b. For a longitudinal reinforcing bar in a column / pedestal, not less than 40 mm, nor less than the diameter of the bar. In case of columns of minimum dimension of 200mm. or under, with reinforcing bars of 12 mm a cover of 25 mm may be used.

c. For longitudinal reinforcing bars in a beams / lintel, not less than 25 mm nor less than the diameter of the bar.

d. For tensile, compressive, shear, or other reinforcement in a slab or wall not less than 20 mm, nor less than the diameter of such reinforcement.

e. For any other reinforcement not less than 20 mm, nor less than the diameter of such reinforcement.

f. For footings and other principal structural members in which the concrete is deposited directly against the ground, cover to the bottom reinforcement shall be 75 mm. If concrete is poured on a layer of lean concrete the bottom cover may be reduced to 50mm.

g. For concrete surfaces exposed to the weather or the ground after removal of forms, such as retaining walls, grade beams, footing sides and top, etc. not less than 50 mm for bars larger than 16mm dia. And not less than 40 mm for bars 16mm dia. or smaller.

h. Increased cover thickness shall be provided, as indicated on the drawings, for surfaces exposed to the action of harmful chemicals (or exposed to earth contaminated by such chemical), acid, alkali, saline atmosphere, sulphurous smoke etc.

i. For liquid retaining structures, the minimum cover to all steel shall be 40 mm or the diameter of the main bar, whichever is greater.

j. For base raft, face in contact with earth or water for underground structures shall be 50 mm and inside face shall be 25 mm.

k. Clear cover for underground RCC hoppers shall be 30 mm.

l. Protection to reinforcement in case of concrete exposed to harmful surroundings may also be given by providing a dense impermeable concrete with approved protective coatings, as specified on the drawings. In such a case the extra cover mentioned in (h) above, may be reduced by Engineer to those shown on the drawings.

m. The correct cover shall be maintained by cement mortar cubes or other approved means. Reinforcement for footings, grade beams and slabs on subgrade shall be supported on precast concrete blocks as approved by Engineer. The use of pebbles or stones shall not be permitted.

n. The 28 days crushing strength of cement mortar cubes/precast concrete cover blocks shall be at least equal to the specified strength of concrete in which these cubes/blocks are embedded.

o. The minimum clear distance between reinforcing bars shall be in accordance with IS: 456 or as shown in drawings.

p. For retaining walls, grade beams, top and sides of footings and similar surfaces exposed to weather or ground, 50mm for bars larger than 16mm and 40mm for bars unto 16mm.

4.2.8 **Inspection**

Erected and secured reinforcement shall be inspected and approved by Engineer prior to placement of concrete.

4.3 **Aggregates**

All aggregates shall conform to IS: 383. The natural aggregates shall be chemically inert, strong, hard, durable, of limited porosity, free from adherent coatings, clay lumps, coal and coal residues and shall contain no organic or other admixtures that may cause corrosion of reinforcement or impair the strength or durability of the concrete. The limits of the content of deleterious materials in aggregate are indicated below: -

**Limits of the content of Deleterious Materials***

| Deleterious Substances | Fine Aggregates | | Coarse Aggregates | |
|---|---|---|---|---|
| | Uncrushed | Crushed | Uncrushed | Crushed |
| Coal and Lignite | 1.00 | 1.00 | 1.00 | 1.00 |
| Clay lumps | 1.00 | 1.00 | 1.00 | 1.00 |
| Soft fragments | -- | -- | 3.00 | -- |
| Material passing 75 micron IS sieve | 3.00 | 3.00 | 3.00 | 3.00 |
| Shale | 1.00 | -- | -- | -- |
| Sum of Percentages | 5.00 | 2.00** | 5.00 | 5.00 |

* Percent by weight of aggregate.
**Sum of percentage of coal and lignite and clay lumps.

Approved natural sand and crushed stone for structural concrete and well washed, thoroughly cleaned and graded natural gravel, shall be used as aggregates for lean and backfill cement concrete. Representative samples of selected aggregates shall be tested at the Contractor's cost of sieve analysis from time to time as required by the Engineer for approval.

4.3.1 **Storage of Aggregates**

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work Site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. The aggregate must be of specified quality not only at the time of receiving at Site but more so at the time of loading into mixer. Rakers shall be used for lifting the coarse aggregates from bins or stockpiles. Coarse aggregate shall be piled in layers not exceeding 1.20 metres in height to

prevent coning or segregation. Each layer shall cover the entire area of the stockpile before succeeding layers are started. Aggregates that have become segregated shall be rejected. Rejected material after remixing may be accepted, if subsequent tests demonstrate conformance with required gradation. After the completion of the piling of the aggregate upto the required height the piled aggregate shall be marked with time.

4.3.2 **Specific Gravity**

Aggregates having a specific gravity below 2.6 (saturated surface dry basis), except for aggregates to be used in lightweight concrete, shall not be used without special permission of engineer.

4.3.3 **Size**

The maximum size of aggregates shall generally be 20mm and as specified on drawing. However, for thick RCC members like rafts, etc. and for lean concrete provided as mud mat below structural concrete, maximum size upto 40mm may be used if so specified on drawings.

## 5.0 FINE AGGREGATES

Fine aggregate (sand) for RCC work shall be the best locally available clean, sharp, coarse sand preferably with a fineness modulus between 2.5 and 3.2 (Fineness modulus is the sum of cumulative percentages retained on the IS sieves given below for gradation divided by 100). The Contractor shall check and ensure that local sand will satisfy this requirement and if necessary shall include for and supply materials from other sources, which comply with the specification

The objectionable foreign matter in sand shall be removed by screening or washing or both as required.

### 5.1 Machine Made Sand

Machine made sand will be acceptable, provided the constituent rock/gravel composition shall be sound, hard, dense, non-organic, uncoated and durable against weathering.

### 5.2 Screening and Washing

Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fractions.

### 5.3 Foreign Material Limitations

The percentages of deleterious substances in sand delivered to the mixer shall not exceed the following:

| | Percent by Weight | |
|---|---|---|
| | Uncrushed | Crushed |
| i. Material finer than 75 micron I.S. sieve | 3.00 | 15.00 |

| | | |
|---|---|---|
| ii. Shale | 1.00 | - |
| iii. Coal and lignite | 1.00 | 1.00 |
| iv. Clay lumps | 1.00 | 1.00 |
| v. Total of all above substances including items (i) to (iv) for uncrushed sand and items (iii) and (iv) for crushed sand. | 5.00 | 2.00 |

5.4 **Gradation**

Unless otherwise directed or approved, the grading of sand shall be within the limits indicated hereunder:

| | PERCENTAGE PASSING FOR | | | |
|---|---|---|---|---|
| **I.S.Sieve Designation** | **Grading Zone I** | **Grading Zone II** | **Grading Zone III** | **Grading Zone IV** |
| 10 mm | 100 | 100 | 100 | 100 |
| 4.75 mm | 90-100 | 90-100 | 90-100 | 95-100 |
| 2.36 mm | 60-95 | 75-100 | 85-100 | 95-100 |
| 1.18 mm | 30-70 | 55-90 | 75-100 | 90-100 |
| 600-micron | 15-34 | 35-59 | 60-79 | 80-100 |
| 300-micron | 5-20 | 8-30 | 12-40 | 15-50 |
| 150-micron | 0-10 | 0-10 | 0-10 | 0-15 |

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron I.S. Sieve, by total amount not exceeding 5 percent, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron I.S. Sieve or to percentage passing any other sieve size on the coarser limit of Grading Zone I or the finer limit of Grading Zone IV. Fine aggregates conforming to Grading Zone IV shall be used unless mix designs and preliminary tests have shown its suitability for producing concrete of specified strength and workability.

5.5 The grading and fineness modulus of sand shall be altered by Engineer depending upon the requirements, suitability and availability. The Contractor shall procure, process and supply the sand at no extra cost to the Purchaser.

5.6 **Soundness**

The average loss of weight for sand after five (5) cycles and subjected to sodium sulphate accelerated soundness test as specified in IS: 2386 (Part 5) shall not be more than 10%.

6.0 **COARSE AGGREGATE**

Coarse aggregate for concrete, except as noted above and for other than light weight concrete shall conform to IS: 383-1970. This shall consist of natural or crushed stone and gravel, and shall be clean, and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

6.1 **Screening and Washing**

6.1.1 Natural gravel and crushed rock shall be screened and/or washed for the removal of dirt or dust coating, if so demanded by Engineer.

6.2 **Grading**

6.2.1 Coarse aggregate shall be whether in single size or grade, in both cases, the grading shall be within the following limits.

| **I.S.Sieve Designation** | Percentage passing for single sized aggregate of nominal size | | | | | **Percentage passing for Graded aggregate of nominal size** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 40mm | 20mm | 16mm | 12.5mm | 10mm | 40mm | 20mm | 16mm | 12.5mm |
| 63mm | 100 | -- | -- | -- | -- | 100 | -- | -- | -- |
| 40mm | 85 – 100 | 100 | -- | -- | -- | 95 – 100 | -- | -- | -- |
| 20mm | 0 – 20 | 85 – 100 | 100 | -- | -- | 30 – 70 | 95 – 100 | 100 | -- |
| 16mm | -- | -- | 85 – 100 | 100 | -- | -- | -- | 90 – 100 | -- |
| 12.5mm | -- | -- | -- | 85 – 100 | 100 | -- | -- | -- | 90 – 100 |
| 10mm | 0 – 5 | 0 – 20 | 0 – 30 | 0 – 45 | 85 – 100 | 10 – 35 | 25 – 55 | 30 – 70 | 40 – 85 |
| 4.75mm | -- | 0 – 5 | 0 – 5 | 0 – 10 | 0 – 20 | 0 – 5 | 0 – 10 | 0 – 10 | 0 – 10 |

| I.S.Sieve Designation | Percentage passing for single sized aggregate of nominal size | | | | | Percentage passing for Graded aggregate of nominal size | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2.36mm | -- | -- | -- | -- | 0 – 5 | -- | -- | -- | -- |

The grading of coarse aggregate shall in general conform to the grading as given in IS: 383. The exact grading of coarse aggregate for different items of cement concrete works shall be approved by Engineer from time to time based on the laboratory test. Such changes in the grading shall be carried out by Contractor at no extra cost.

6.2.2 the pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only in such quantities that will not, in the opinion of Engineer, affect adversely the strength and/or durability of concrete. The maximum size of coarse aggregate shall be the maximum size specified above, but in no case greater than one fourth (1/4) of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. Plums above 160 mm and upto any reasonable size can be used in plain mass concrete work of large dimensions upto a maximum limit of 20% by volume of concrete when specifically approved by Engineer. Plums shall be distributed evenly and shall be not closer than 150mm from the surface. For heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5mm less than the minimum clear distance between the reinforcing main bars or 5mm less than the minimum cover to the reinforcement whichever is smaller. The amount of fine particles occurring in the free state or as loose adherent shall not exceed 1% when determined by laboratory sedimentation tests as per IS: 2386.

Should at any time the Engineer have reason to consider any aggregate defective or of poor quality, then irrespective of any previous approval or tests, representative samples of such materials shall be immediately tested and until the results of such tests prove the material to be satisfactory, it shall not be used for any work. The Contractor shall not be entitled to any claim of any nature on this account. The cost of these tests (including collection of samples and transportation) shall be borne by the Contractor.

6.3 **Foreign Material Limitations**

The percentages of deleterious substances in the aggregate delivered to the mixer shall not exceed the following:

| | Percent by Weight | |
|---|---|---|
| | Uncrushed | Crushed |

| | | | |
|---|---|---|---|
| i. | Material finer than 75 micron I.S. sieve | 3.00 | 3.00 |
| ii. | Coal and lignite | 1.00 | 1.00 |
| iii. | Clay lumps | 1.00 | 1.00 |
| iv. | Soft fragments | 3.00 | - |
| v. | Total of all the above substances | 5.00 | 5.00 |

6.4 **Crushing Value**

The aggregate crushing value, when determined in accordance with IS: 2386 (Part-IV) shall not exceed forty five (45) percent for aggregate used for concrete other than for wearing surfaces and thirty (30) percent for concrete for wearing surfaces.

6.5 **Impact Value**

As an alternative to clause 6.4 the aggregate impact value may be determined in accordance with the method specified in IS: 2386 (Part IV). The impact value shall not exceed forty-five (45) percent by weight for aggregates used for concrete other than for wearing surfaces and thirty (30) percent by weight for concrete for wearing surfaces.

6.6 **Abrasion Value**

Unless otherwise agreed to between the Purchaser and the Supplier the abrasion value of aggregates, when tested in accordance with the method specified in IS: 2386 (Part IV), using Los Angeles Machine, shall not exceed the following values: -

| | | |
|---|---|---|
| A. | For aggregates to be used In concrete for wearing Surfaces. | Thirty (30) percent |
| B. | For aggregates to be used in other concrete (structural) | Forty five (45) percent. |

7.0 **WATER**

7.1 Water used for both mixing and curing shall be free from injurious amounts of deleterious materials. Potable waters are generally satisfactory for mixing and curing concrete.

7.2 In case of doubt, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time test specified in IS: 456. The sample of water taken for testing shall be typical of the water proposed to be used for concreting, due account being paid to seasonal variation. The sample shall not receive any treatment before testing other than that envisaged in the regular supply of water proposed for use in

concrete. The sample shall be stored in a clean container previously rinsed out with similar water. The PH-value of water to be used shall not be less than 6.

7.3 Average 28 day compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water.

7.4 The initial setting time of test block made with the appropriate test cement and the water proposed to be used shall not be less than 30 minutes and shall not differ by more than ± 30 minutes from the initial setting time of control test block prepared with the appropriate test cement and distilled water. The test blocks shall be prepared and tested in accordance with the requirements of I.S. 4031.

7.5 Where water can be shown to contain an excess of acid, alkali, sugar or salt, Engineer may refuse to permit its use. The following concentrations represent the maximum permissible values:

| | **Permissible limit** |
|---|---|
| 1) Organic | 200mg/lit. |
| 2) Inorganic | 3000mg/lit. |
| 3) Sulphates (as SO4) | 500mg/lit. |
| 4) Chlorides (as Cl) | 2000 mg/lit. For plain workand1000 mg/lit. for concrete reinforced cement concrete work) |
| 5) Suspended matter | 2000 mg/lit. |

## 8.0 CONTROLLED CONCRETE

All concrete in the works shall be "Controlled Concrete" as defined in I.S.456, unless it is a nominal mix concrete such as 1:3:6, 1:4:8 or 1:5:10. The proportioning of concrete, the quantity of both cement and aggregates should be determined by weight. Cement shall be measured by weight but aggregates may be converted into their volumetric equivalent to facilitate work. Water should be either measured by volume in calibrated tank or by weight. All the measuring conditions and the accuracy may be periodically checked.

## 8.1 NOMINAL MIX CONCRETE

a) Nominal mix concrete shall be used only for plain cement concrete works and where shown on drawings or specifically allowed by the Engineer. Such concrete shall not required preparation of trial mixes and all such concrete shall be mixed in a mechanical mixer. Proportions for nominal mix concrete shall be according to Table-9 of IS: 456-2000. In addition standard proportion by volume shall be used wherever specified.

b) In proportioning concrete, the cement shall be measured by (mass) weight. The quantities of fine and coarse aggregates may be determined by volume (for corresponding weight) but preferably by weight. If fine aggregates are moist, the amount of surface water shall be determined. Also an allowance shall be made for bulking in case of volume batching, in accordance with IS: 2386 (Part-III). Allowance shall also be made for surface water present in the aggregates, when computing the water requirement. All the above data shall be maintained properly, to the satisfaction of the Engineer.

c) The recommended maximum water cement ratios are specified in Table-1.

**TABLE –1**
**RECOMMENDED WATER CEMENT RATIO**

| Nominal mix concrete | Quantity of water per 50kg of cement |
|---|---|
| 1:5:10 | 60 liters |
| 1:4:8 | 45 liters |
| 1:3:6 | 34 liters |
| 1:2:4 | 32 liters |

d) Nominal mix concrete 1:5:10 shall correspond to grade M5, 1:4:8 shall correspond to grade M7.5, 1:3:6 to grade M10 and 1:2:4 to grade M15 of IS: 456.

e) If nominal mix concrete made in accordance with specified proportions does not yield the specified strength of the corresponding grade and fails to satisfy the requirements of “acceptance criteria of concrete” as specified in IS: 456, such concrete shall be treated in the following manner:

i) In case the Engineer is satisfied that lower strength of concrete is attributed to material and workmanship of the Contractor, then such concrete shall be replaced by concrete of specified strength. The Engineer may, however, also accept such lower strength concrete but such lower strength concrete shall be classified as belonging to the appropriate lower grade proportion.

ii) In case the Engineer is satisfied that lower strength of concrete is not attributable to the Contractor, he may direct in writing to increase the cement content to obtain specified strength at no extra cost of Owner. The use of richer mix shall be continued until the Engineer instructs otherwise.

f) Nominal mix proportion shall not be classified as higher-grade proportion either on the ground that the test strengths are higher than the minimum specified strength at no extra cost to Owner. The use of richer mix shall be continued until the Engineer instructs otherwise.

## 9.0 COMPRESSIVE STRENGTH OF THE CONCRETE

9.1 Minimum compressive strength of 15cm cubes shall be as follows: -

| Grade of Concrete | Preliminary test at twenty eight (28) days ($N/mm^2$) | Work test at seven (7) days ($N/mm^2$) | Work test At twenty eight (28) days ($N/mm^2$) |
|---|---|---|---|
| M15 | 20 | 12 | 15 |
| M20 | 26 | 18 | 20 |
| M25 | 32 | 20 | 25 |
| M30 | - | - | 30 |
| M35 | - | - | 35 |

## 10.0 PRELIMINARY TEST

10.1 Test specimens shall be prepared with at least two different water/cement ratios for each class of concrete consistent with workability required for the nature of the work. The materials and proportions used in making preliminary tests shall be similar in all respects to those to be actually employed in the works as the object of these tests is to determine the proportions of cement, aggregate and water necessary to produce concrete of required consistency and to give the specified strength. It shall be the Contractor's sole responsibility to carryout these tests. He shall furnish to the Engineer a statement of proportions proposed to be used for the various concrete mixes.

10.2 For the preliminary tests, the concrete shall be mixed by hand or in a small batch mixer as per IS: 516 in such a manner as to avoid loss of water. Each batch of concrete shall be of such a size as to leave about 10% excess concrete, after molding the desired number of test specimens.

10.3 The consistency of each batch of concrete shall be measured immediately after mixing by the slump test in accordance with IS: 1199. The concrete test cubes shall be moulded by placing fresh concrete in the mould and compacted as specified in IS: 516. Curing shall be as specified in IS: 516. The compression tests of concrete cubes shall be carried out as per IS: 516 on fifteen (15) centimeter cubes.

10.4 The strength shall be determined based on not less than five cube test specimens for each age and each water cement ratio.

10.5 The test results shall be accepted by Engineer if the average compressive strengths of the specimens tested is not less than the compressive strength specified for the age at which specimens are tested, subject to the condition that only one out of the five consecutive tests may give a value less than the specified strength for that age. Engineer may direct Contractor to repeat the tests if the results are not satisfactory and also to make such change as he considers necessary to meet the requirements specified. All these preliminary tests shall be conducted by Contractor at his own cost in an approved laboratory. All testing shall be carried out as per IS: 516.

10.6 Work test shall be performed according to the following schedule:

Six (6) cubes of 15cm sides for every 150 cubic metre of concrete or for a shift of eight hours of concreting; of which three (3) shall be tested at tested at seven (7) days and three (3) at twenty eight (28) days. Concrete shall be considered unsatisfactory if the average strength of three - 28 days' cubes is below the specified value. However, only one of the three consecutive tests may give a value less than the specified strength but this shall not be less than 90% of the specified strength. Samples shall be taken while concrete is being poured in the presence of representatives appointed by the Engineer.

## 11.0 MIX DESIGN

11.1 All the preliminary tests and all mix design work and testing of samples/cubes etc. shall be got done by the Contractor at his own cost. The Contractor shall make all arrangements for transportation of samples from quarry/workshop to laboratory, he shall be required to associate himself with Purchaser in evolving the required design mixes by assigning the job to a qualified engineer under his employment.

## 12.0 MIXING OF CONCRETE

Cement, sand and crushed stone shall be measured by weight as directed by the Engineer-in-Charge; the components of the concrete shall be batched in such a way that each batch contains a whole number of cement bags. Concrete shall be mixed in concrete mixers of a size and type previously certified acceptable to the Engineer. Concrete shall be mixed in the machine for at least one (1) minute dry and for at least one and a half minutes after adding water. Mixed concrete shall be of even colour and uniform consistency.

12.01.1 Concrete shall be mixed only in such quantities as are required for immediate use. No more concrete shall be mixed in any one lot than that can be laid in position before the 'initial setting' occurs. Partly set or re-tampered concrete shall not be used. After the finish of each day's work the mixing plats shall be thoroughly washed and cleaned. On commencing work, the first batch shall have 10% additional cement.

12.01.2 the mixer and weigh batchers shall be maintained in a clean, serviceable condition. The accuracy of weigh batchers shall be periodically checked. They shall be set up level on a firm base and the hopper shall be loaded evenly. The needle shall be adjusted to zero when the hopper is empty. Fine and coarse aggregates shall be weighed separately. Volume batching will not be permitted. All concrete shall be mixed in mechanically operated batch mixers complying with IS: 1791 and of approved make with suitable provision for directly controlling the water delivered to the drum.

12.01.3 the water cement ratio to be adopted shall be determined in each case by the Contractor as frequently as desired by the Engineer-in-Charges and shall be approved by him.

12.2 **Consistency and workability of Concrete**

Consistency and workability of concrete shall be checked by measuring the slump of a truncated cone of concrete straight from the mixer under normal working conditions. The conical mould shall be of metal, 300mm high and 100mm and 200mm in diameter at top and base respectively.

12.2.1 Moulds shall be prepared by the Contractor. The slump range of concrete shall be as mentioned below.

12.2.2 Slump tests shall be performed as per IS:1199 at intervals established by the Engineer at the Contractor's cost in such a way as to check that the degree of consistency established by the Engineer for work in progress is maintained. The table below gives the general slump range to be followed for various types of construction unless otherwise shown on drawings of instructed by the Engineer.

**SLUMP FOR VARIOUS TYPES OF CONSTRUCTION**

| Various types of Construction | Slump mm Max. | Min. |
|---|---|---|
| Reinforced foundation walls and footings. | 80 | 35 |

| | | |
|---|---|---|
| Plain footings & Sub-structure walls | 75 | 35 |
| Slabs, beams & Reinforced walls | 100 | 50 |
| Pumps & other Misc. equipment foundation | 75 | 35 |
| Heavy Mass Construction | 50 | 35 |

12.03 **Compaction Factor Test**

The workability test by means of compaction factor tests as per IS: the Contractor at his cost shall also carry out 1199.

12.04 **Batching and Mixing of Concrete**

The material and proportions of concrete materials as established by the preliminary tests for the mix design shall be rigidly followed for all concrete on the Project and shall not be changed except when specifically permitted by Engineer.

12.04.1 Concrete shall be produced only by weigh batching the ingredients. The mixer and weigh batchers shall be maintained in clean, serviceable condition. The accuracy of weigh batchers shall be periodically checked.

13.0 **SAMPLING AND TESTING CONCRETE IN THE FIELD**

Facility required for sampling materials & concrete in the field shall be provided by Contractor without any extra cost and the tests shall be got done by the Contractors at his own expense. The following equipment with operator shall be made available at Engineer's request (all must be in serviceable condition):

| | | |
|---|---|---|
| 1. | Concrete cube testing machine suitable for 15 Cm. cubes of 100 Tones capacity With proving calibration ring. | 1 No. |
| 2. | Cast iron cube moulds 15 cm size | 6Nos. (Min) |
| 3. | Slump cone complete with tamping rod | 1 set |
| 4. | Laboratory balance to weigh upto 5 Kg. with sensitivity of 10 Gm. | 1 No. |
| 5. | IS sieves for coarse and fine aggregates | 1 set |
| 6. | A set of measures from 5 to 0.1 | 1 set |
| 7. | Electric oven with thermostat up to 120 Deg.C | 1 No. |
| 8. | Flakiness gauge | 1 No. |

| | | |
|---|---|---|
| 9. | Elongation index gauge | 1 No. |
| 10. | Sedimentation pipette | 1 No. |
| 11. | Pycnometer | 1 No. |
| 12. | Calibrated glass jar I liter capacity | 2 Nos. |
| 13. | Glass flasks & metal containers | as required |
| 14. | Chemical reagents like sodium hydroxide, tannic acid, litmus papers etc. | as required |
| 15. | Laboratory balance of 2 Kg. capacity | 1 No. and of sensitivity of 1 gm. |

## 14.0 ADMIXTURES

### 14.1 General

Admixtures shall be supplied by Contractor. Admixtures may be used in concrete only with the approval of Engineer based upon evidence that, with the passage of time, neither the compressive strength nor its durability reduces. Calcium chloride shall not be used for accelerating setting of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted to be used, such as in mass concrete works, it shall be dissolved in water and added to the mixing water in an amount not to exceed 1-1/2 percent of the weight of the cement in each batch of concrete. When the admixtures are used the designed concrete mix shall be corrected accordingly. ISI mark Admixtures shall be used as per manufacturer's instructions and in the manner and with the control specified by Engineer.

14.1.1 To minimize the deterioration of concrete from harmful chemical salts, the levels of such salts in concrete coming from the concrete materials i.e. cement, aggregates, water and admixtures as well as by diffusion from the environments should be limited. Generally the total amount of chlorides (as Cl) and the total amount of soluble sulphates (as SO3) in the concrete at the time of placing should be limited to 0.15 percent of mass of cement and 4 percent by mass of cement respectively.

### 14.2 Air Entraining Agents

Neutralized Vinsol Resin or any other approved air entraining agent may be used to produce the specified amount of air in the concrete mix and

these agents shall conform to the requirements of ASTM standard 6-260; Air Entraining Admixtures for concrete. The recommended total air content of the concrete is 4% (±1%). The method of measuring air content shall be as per IS: 1199.

14.3 **Water Reducing Admixtures**

Water reducing lingo sulfonate mixture shall be added in quantities specified by Engineer. The admixtures shall be added in the form of a solution.

14.4 **Retarding Admixtures**

Where specified and approved by Engineer, retarding agents shall be added to the concrete mix in quantities specified by Engineer.

14.5 **Water Proofing Agent**

Where specified and approved by Engineer, ISI marked water proofing agent conforming to IS: 2645, shall be added in quantities specified by Engineer.

14.6 **Other Admixtures**

Engineer may at his discretion instruct Contractor to use any other admixture in the concrete.

## 15.0 LOAD TEST ON MEMBERS OR ANY OTHER TESTS

15.1 In the event of any work being suspected of faulty material or workmanship or both, Engineer requiring its removal and reconstruction may order, or Contractor may request that it should be load tested in accordance with the following provisions:

15.2 The test load shall be 125 percent of the maximum super-imposed load for which the structure was designed. Such test load shall not be applied before 28 days after the effective hardening of concrete. During the test, struts strong enough to take the whole load shall be placed in position leaving a gap under the members. The test load shall be maintained for 24 hours before removal.

15.3 If within 24 hours of the removal of the load, the structure does not show a recovery of at least 75 per cent of the maximum deflection shown during the 24 hours under load, the test loading shall be repeated after a

lapse of at least 72 hours. The structure shall be considered to have failed to pass the test if the recovery after the second test is not at least 80 percent of the maximum deflection shown during the second test. If the structure is certified as failed by the Engineer, the cost of the load test shall be borne by the Contractor.

15.4 Any other tests, e.g. taking out in an approved manner concrete cores, examination & tests on such cores removed from such parts of the structure as directed by Engineer, ultrasonic testing etc. shall be carried out by Contractor if so directed. If the tests show unsatisfactory results due to reasons attributable to Contractor the cost of such tests shall have to be borne by Contractor, otherwise such costs will be borne by Purchaser.

15.5 **Unsatisfactory Tests**

Should the results of any test prove unsatisfactory, or the structure shows signs of weakness, undue deflection or faulty construction Contractor shall remove and rebuild the member or members involved or carry out such other remedial measures as may be required by Engineer/Purchaser. Contractor shall bear the cost of so doing, unless the failure of the member or members to fulfill the test conditions is proved to be solely due to faulty design.

## 16.0 PREPARATION PRIOR TO CONCRETE PLACEMENT, FINAL INSPECTION AND APPROVAL

16.1 Before the concrete is actually placed in position, the insides of the formwork shall be inspected to see that they have been cleaned and oiled. Temporary opening shall be provided to facilitate inspection, especially at bottom of columns and wall forms, to permit removal of saw dust, wood shavings, binding wire, rubbish, dirt etc. Openings shall be placed or holes drilled so that these materials and water can be removed easily. Such openings/holes shall be later suitably plugged.

16.2 The various trades shall be permitted ample time to install drainage and plumbing lines, floor and trench drains, conduits, hangers, anchors, inserts, sleeves, bolts, frames and other miscellaneous embedments to be cast in the concrete as is necessary for the proper execution of the work. Contractor shall cooperate fully with all such agencies, and shall permit the use of scaffolding, form work etc., by other trades at no extra cost.

16.3 All embedded parts, inserts etc. supplied by Purchaser or Contractor shall be correctly positioned and securely held in the forms to prevent displacement during depositing and vibrating of concrete. Inserts etc. will

have to be welded to reinforcement, if required, to keep them in position, as directed by Engineer.

16.4 All anchor bolts shall be positioned and kept in place with the help of properly manufactured templates unless specifically waived in writing by Engineer. The use of all such templates, fixtures etc. shall be deemed to be included in the rates.

16.5 Slots, openings, holes, pockets etc. shall be provided in the concrete work in the positions as directed by Engineer.

16.6 Reinforcement and other items to be cast in concrete shall have clean surfaces that will not impair bond.

16.7 Prior to concrete placement all work shall be inspected and approved by Engineer and if found unsatisfactory, concrete shall not be poured until after all defects have been corrected at Contractor's cost.

16.8 Approval by Engineer of any and all materials and work as required herein shall not relieve Contractor from his obligation to produce finished concrete.

16.9 **Rain or Wash Water**

No concrete shall be placed in wet weather or on a water covered surface. Any concrete that has been washed by heavy rains shall be entirely removed, if there is any sign of cement and sand having been washed away from the concrete mixture. To guard against damage which may be caused by rains, the works shall be covered with tarpaulins immediately after the concrete has been placed and compacted before leaving the work unattended. Any water accumulating on the surface of the newly placed concrete shall be removed by approved means and no other concrete shall be placed thereon until such water is removed. To avoid flow of water over/around freshly placed concrete, suitable drains and sumps shall be provided.

16.10 **Bonding Mortar**

Immediately before concrete placement begins, prepared surfaces except formwork which will come in contact with the concrete to be placed, shall be covered with a bonding mortar as specified in this section.

17.0 **TRANSPORTATION**

17.1 All buckets, containers or conveyors used for transporting concrete shall be mortar-tight. Irrespective of the method of transportation adopted, concrete shall be delivered with the required consistency and plasticity

without segregation or loss of slump. However, chutes shall not be used for transport of concrete without the written permission of Engineer and concrete shall not be rehandled before placing.

17.2 **Retempered or Contaminated Concrete**

Concrete must be placed in its final position before it becomes too stiff to work. On no account, water shall be added after the initial mixing. Concrete which has become stiff or has been contaminated with foreign materials shall be rejected and disposed off as directed by Engineer.

18.0 **PROCEDURE FOR PLACING OF CONCRETE**

18.1 **Engineer's Approval for Equipment and Methods**

Before any concrete is placed, the entire placing programme, consisting of equipment layout, proposed procedures and methods shall be submitted to Engineer for approval if so demanded by Engineer and no concrete shall be placed until Engineer's approval has been received. Equipment for conveying concrete shall be of such size and design as to ensure a practically continuous flow of concrete during depositing without segregation of materials, considering the size of the job and placement location.

18.2 **Time Interval Between Mixing and Placing**

Concrete shall be placed in its final position before the cement reaches its initial set and concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer, and once compacted it shall not be disturbed.

18.3 **Avoiding Segregation**

Concrete shall, in all cases, be deposited as nearly as practicable directly in its final position, and shall not be rehandled or caused to flow in a manner which will cause segregation, loss of materials, displacement of reinforcement, shuttering or embedded inserts or impair its strength. For locations where direct placement is not possible, and in narrow forms, Contractor shall provide suitable drop and "Elephant Trunks" to confine the movement of concrete. Special care shall be taken when concrete is dropped from a height, especially if reinforcement is in the way, particularly in columns and thin walls.

18.4 **Placing by Mechanical Equipment**

18.4.1 The following specification shall apply when placing of concrete by use of mechanical equipment is specifically called for while inviting bids or is warranted considering the nature of work involved.

The control of placing shall begin at the mixer discharge. Concrete shall be discharged by a vertical drop into the middle of the bucket or hopper and this principle of a vertical discharge of concrete shall be adhered to throughout all stages of delivery until the concrete comes to rest in its final position.

18.4.2 **Concrete in Layers**

Concreting, once started, shall be continuous until the pour is completed. Concrete shall be placed in successive horizontal layers of uniform thickness ranging from 15 to 30 cm as directed by Engineer. These shall be placed as rapidly practicable to prevent the formation of cold joints or planes of weakness between each succeeding layer within the pour. The thickness of each layer shall be such that it can be deposited before the previous layer has stiffened. The bucket loads or other units of deposit, shall be spotted progressively along the face of the layer with such overlap as will facilitate spreading the layer to uniform depth and texture with a minimum of shovelling. Any tendency to segregation shall be corrected by shovelling stones into mortar rather than mortar on to stones. Such a condition shall be corrected by redesign of mix or other means, as directed by Engineer.

18.4.3 **Bedding of Layers**

The top surface of each pour and bedding planes shall be approximately horizontal unless otherwise instructed.

18.4.4 **Vibration**

Concrete shall be compacted during placing, with approved vibrating equipment until the concrete has been consolidated to the maximum practicable density, is free of pockets of coarse aggregate and fits tightly against all form surfaces, reinforcement and embedded fixtures. Particular care shall be taken to ensure that all concrete placed against the form faces and into corners of forms or against hardened concrete at joints is free from voids or cavities. The use of vibrators shall be consistent with the concrete mix and caution exercised not to over vibrate the concrete to the point that segregation results. Concrete to be vibrated shall be placed in level layers of suitable thickness not greater than the effective length of the vibrator needle. The concrete at the surface shall be distributed as horizontally, as possible, the vibration shall not be done in the neighbourhood of slopes. The internal vibrator shall not be used to spread the concrete for filling. It is advisable to deposit concrete well in advance of the point of vibration. When the concrete is being continuously deposited to a uniform depth along a member, vibrator shall not be operated too near to the free end of the advancing concrete, usually not within 1.20 metres of it. Every effort shall be

made to keep the surface of the previously placed layer of concrete alive so that the succeeding layer can be amalgamated with it by vibration process. The concrete shall be placed in shallow layers consistent with the method being used to place and vibrate the concrete. Usually concrete shall be placed in thickness not more than 300mm and on initial placing in thickness not more than 150mm.

18.4.5 **Type of Vibrators**

Vibrators shall conform to IS Specifications. Type of vibrator to be used shall depend on the structure where concrete is to be placed. Shutter vibrators to be effective, shall be firmly secured to the form work which must be sufficiently rigid to transmit the vibration and strong enough not to be damaged by it. Immersion vibrators shall have "no load" frequency, amplitude and acceleration as per I.S. 2505 depending on the size of the vibrator. Immersion vibrators in sufficient numbers and each of adequate size shall be used to properly consolidate all concrete. Tapping or external vibrating of forms by hand tools or immersion vibrators will not be permitted.

18.4.6 **Use of Vibrators**

The exact manner of application and the most suitable machines for the purpose must be carefully considered and operated by experienced men. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn when air bubbles cease to come to the surface. Immersion vibrators shall be withdrawn very slowly usually at the rate of 75 mm per second. In no case shall immersion vibrators be used to transport concrete inside the forms. Particular attention shall be paid to vibration at the top of a lift e.g. in a column or wall.

18.4.7 **Melding Successive Batches**

When placing concrete in layers, which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, blending and melding of the concrete between the succeeding layers.

18.4.8 **Penetration of Vibrator**

The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the underlayer is still plastic upto a depth of 10 to 20mm to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

18.4.9 **Stone Pockets and Mortar Pondages**

The formation of stone pockets or mortar pondages in corners and against faces of forms shall not be permitted. Should these occur, they

shall be dug out, reformed and refilled to sufficient depth and shape for thorough bonding, as directed by Engineer.

18.5 **Placement Interval**

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for atleast 24 hours after the final set of concrete and before the start of a subsequent placement.

18.6 **Special Provision in Placing**

When placing concrete in walls with openings, in floors of integral slab and beam construction and other similar conditions, the placing shall stop when the concrete reaches the top of the opening in walls or bottom horizontal surface of the slab, as the case may be. Placing shall be resumed before the concrete in place takes initial set, but not until it has had time to settle as determined by Engineer.

18.7 **Placing Concrete Through Reinforcing Steel**

When placing concrete through reinforcing steel, care shall be taken to prevent segregation of the coarse aggregate. Where the congestion of steel makes placing difficult, it may be necessary to temporarily move the top steel aside to get proper placement and restore reinforcing steel to design position.

18.8 **Bleeding**

Bleeding or free water on top of concrete being deposited into the forms, shall be a cause to stop the concrete pour and the conditions causing this defect corrected before any further concreting is resumed.

19.0 **CONSTRUCTION JOINTS AND KEYS**

19.1 Concrete shall be placed without interruption until completion of the part of the work between predetermined construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made where the work is stopped. The concrete shall be rebated and/or keyed at the Joint to such shape and size as may be required by the Engineer. Joints shall be either vertical or horizontal. In case of an inclined or curved member, the joint shall be at right angles to the axis of the member. Vertical joints shall be formed against a stop board; which are rigidly fixed and slotted to allow for the passage of the reinforcing steel, horizontal joints shall be level and wherever possible, arranged so that the joint lines coincide with the architectural features of the finished work. Battens shall be nailed to the form work so as to ensure a horizontal line and if directed, shall also be used to form a grooved joint. Horizontal and vertical

construction joints and shear keys shall be located and shall conform in detail to the requirements of the plans unless otherwise directed by Engineer.

19.2 **Locations Of Joints:**

Construction joints shall be located as shown or described on the drawings. Where it is not described, the joints shall be in accordance with the following guidelines.

i) In a column, the joints shall be formed about 75mm below the lowest soffit of the beams framing into it, including haunches, if any. In flat slab construction, the joint shall be 75mm below the soffit of the column capital.

ii) Concrete in a beam shall be placed throughout without a joint. If unavoidable, the joint shall be vertical and within the middle-third of the span. When a beam intersects a girder, the joints in the girder shall be given an offset equal to a distance twice the width of the beam and additional reinforcement provided for shear. The joints shall be vertical throughout the full thickness of the concrete member with suitable shear key wherever shown on the drawing.

iii) A joint in a suspended floor slab shall be vertical at one quarter points of the span and at right angle of the principal reinforcement.

iv) Construction joints in equipment foundations shall not be provided without specific concurrence of the Engineer.

v) Vertical construction joints in equipment foundations shall not be provided without specific concurrence of the Engineer.

vi) Vertical construction joints in water retaining structures shall not be permitted unless shown on the drawings.

However, if the Contractor desires any adjustments in the location of construction joints (to suit site conditions) from those shown on drawings or from those explained above, he shall obtain prior approval from the Engineer.

19.3 **Dowels**

Dowels for concrete work, not likely to be taken up in the near future, shall be wrapped in tar paper and burlap.

19.4 **Mass Foundations**

Mass foundations shall be poured in lifts not exceeding 1.5 m in height unless otherwise indicated on the drawings or approved by Engineer.

## 20.0 TREATMENT OF CONSTRUCTION JOINTS ON RESUMING CONCRETING

A drier mix shall be used for the top lift of horizontal pours to avoid laitance. All laitance and loose stones shall be thoroughly and carefully removed by wire brushing/hacking and surface washed.

Just before concreting is resumed, the roughened joint surface shall be thoroughly cleaned and loose matter removed and then treated with a thin layer of cement grout of proportion specified by Engineer and worked well into the surface. The new concrete shall be well worked against the prepared face before the grout mortar sets. Special care shall be taken to obtain thorough compaction and to avoid segregation of the concrete along the joint plane.

### 20.1 Expansion and Contraction Joints

Provision shall be made for expansion and contraction in concrete by use of special type joints located suitably. The bitumen impregnated fibre board shall be used as joint filler which shall fill space between the concrete surface at the joints. The minimum thickness shall be 12mm and the material shall conform to IS:1838.

## 21.0 CURING, PROTECTING, REPAIRING AND FINISHING

### 21.1 Curing

21.01.1 All concrete shall be cured by keeping it continuously damp for the period of required time for complete hydration and hardening to take place. Preference shall be given to the use of continuous sprays, of ponded water, continuously saturated coverings of sacking, canvas, hessian or other absorbent materials, or approved effective curing compound applied with spraying equipment capable of producing a smooth, even-textured coat. Extra precautions shall be exercised in curing concrete during cold and hot weather as outlined hereinafter. The quality of curing water shall be the same as that used for mixing concrete.

21.01.2 Certain types of finish or preparation for overlaying concrete must be done at certain stages of the curing process and special treatment may be required for specific concrete surface finish.

21.01.3 Curing of concrete made of high alumina cement and supersulphated cement shall be carried out as directed by Engineer.

### 21.02 Curing with Water

Fresh concrete shall be kept continuously wet for a minimum period of 10 days from the date of placing of concrete, following a lapse of 12 to 14 hours after laying concrete. The curing of horizontal surfaces exposed to the drying winds shall however begin immediately after the concrete has hardened. Water shall be applied to unformed concrete surfaces within one (1) hour after concrete has set. Water shall be applied to formed surfaces immediately upon removal of forms. Quantity of water applied shall be controlled so as to prevent erosion of freshly placed concrete.

21.03 **Continuous Spraying**

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances of hose, sprinklers and spraying devices. Continuous fine mist spraying or sprinkling shall be used, unless otherwise specified or approved by Engineer.

21.04 **Alternate Curing Methods**

21.04.1 Whenever, in the judgment of Engineer, it may be necessary to omit the continuous spray method, a covering of clean sand or other approved means such as wet gunny bags which will prevent loss of moisture from the concrete may be used. No type of covering will be approved which would stain or damage the concrete during or after the curing period. Covering shall be kept continuously wet during the curing period.

21.05 **Curing Equipment**

All equipment and materials required for curing shall be on hand and ready for use before concrete is placed.

21.06 **Concrete for Equipment or Steel Structures Foundations**

21.06.1 Concrete for equipment foundation, whether principal or auxiliary, shall be poured continuously so that the structure becomes monolithic, particular care being exercised to see that the base slabs, if any, are of compact impervious construction. Tunnels, passages apertures and so forth shall be provided in accordance with the drawings for the installation of mechanical and electrical equipment, pipes or cables. The top elevation of the equipment foundations or parts shall be accurately cast to 20/50mm (or more as may be specified on the drawings) above the level required for grouting and it shall be pneumatically chiseled off and well roughened just prior to the erection of the equipment concerned. All embedded anchor bolts or bolt sleeves shall be accurately and firmly set with the aid of approved templates, steel supports and/or other accessories. For holding the embedded bolts or sleeves in the correct position during concreting, template shall have to be of steel of suitable

section approved by the Engineer. Two (2) sets of templates shall have to be provided, one to hold the bottom and the other the top of the bolts or sleeves. The bottom template shall be securely and rigidly fixed by providing anchorage arrangement and by welding to the lowest part of the steel reinforcement and other structural supports. The top templates shall be securely fixed by tying with guy wires and turn buckle arrangement to firm and rigid adjoining structures and stagings.

21.06.2 Bolt pockets, where required, shall be cast with wooden taper wedges. These shall be withdrawn at an appropriate time when the concrete has set, the pockets cleaned roughened and then covered or blocked thoroughly to prevent debris getting into these. The exposed portions of bolts and embedded parts shall be kept well greased and adequately protected from damage throughout construction. Any damages found shall have to be corrected at the Contractor's cost. The Purchaser shall have the right to use the foundations, pads, piers, slabs, floors and all concrete work as needed for other works or equipment erected prior to its `Taking Over'.

21.07 **Jointing with Adjacent Works**

The Contractor shall bond new work to adjacent completed work, as shown in the drawing or as directed, by chipping, cutting or drilling of old concrete, by embedding new dowels in old concrete, or by exposing and cleaning the reinforcement of the old structure and lapping/welding new reinforcement to obtain continuity. All precautions as specified for preparing construction joints, shall also be taken for this work.

21.08 **Concreting in Too Hot Weather**

All concrete work performed in hot weather shall be in accordance with IS:456. Concrete shall not normally be placed when the atmospheric temperature exceeds 40 degrees centigrade in the open. If, inspite of programming concrete work in the cooler hours of early morning, evening or night placement is necessary in too hot a weather, then the Contractor shall take the following other precautions:

- Admixtures may be used only when approved by Engineer.

- Stock-pile aggregates in shade.
- Do not use fresh factory hot cement.

- Use cold water/crushed ice.

- Cool formwork by sprinkling water without collecting water inside.

- Reduce to minimum the time interval between mixing and placing.

- Place, vibrate and finish as quickly as possible.

- Initiate curing as soon as concrete hardens.

21.09 **Concrete in Cold Weather**

Special precautions specified in IS:456 shall be taken, should concreting be necessary when atmospheric temperature in the open is below five (5) degrees centigrade.

21.10 **Protecting Fresh Concrete**

Fresh concrete shall be protected from the elements, from defacements and damage due to construction operations by leaving forms in place for an ample period as specified later in this specification. Newly placed concrete shall be protected by approved means such as tarpaulins from rain, sun and winds. Steps as approved by Engineer shall also be taken to protect immature concrete from damage by debris, excessive loading, vibration, abrasion or contact with other materials etc. that may impair the strength and/or durability of the concrete. Workmen shall be warned against and prevented from disturbing green concrete during its setting period. If it is necessary that workmen enter the area of freshly placed concrete, Engineer may require that bridges be placed over the area.

21.11 **Repair and Replacement of Unsatisfactory Concrete**

21.11.1 Immediately after the shuttering is removed, the surface of concrete shall be very carefully gone over and all defective areas called to the attention of Engineer who may permit patching of the defective areas or also reject the concrete unit either partially or in its entirety. Rejected concrete shall be removed and replaced by Contractor at no additional expense to Purchaser. Holes left by form bolts etc. shall be filled up and made good with mortar composed of one part of cement to one and half parts of sand passing 4.75 mm I.S. sieve after removing any loose stones adhering to the concrete. Mortar filling shall be struck off flush at the face of the concrete. Concrete surfaces shall be finished as described under the particular items of work.

21.11.2 Superficial honeycombed surfaces and rough patches shall be similarly made good immediately after removal of shuttering, in the presence of Engineer and superficial water and air holes shall be filled in. The mortar shall be well worked into the surface with a wooden float. Excess water shall be avoided. Unless instructed otherwise by Engineer, the surface of the exposed concrete placed against shuttering shall be rubbed down immediately on removal of shuttering to remove fine or other irregularites,

care being taken to avoid damaging the surface. Surface irregularities shall be removed by grinding.

21.11.3 If reinforcement is exposed or the honey combing occurs at vulnerable positions e.g. ends of beams or columns it may be necessary to cut out the member completely or in part and reconstruct. The decision of Engineer shall be final in this regard. If only patching is necessary, the defective concrete shall be cut out till solid concrete is reached (or to a minimum depth of 25 mm) the edges being cut perpendicular to the affected surface or with a small under cut if possible. Anchors, tees or dovetail slots shall be provided whenever necessary to attach the new concrete securely in place. An area extending several centimetres beyond the edges and the surfaces of the prepared voids shall be saturated with water for 24 hours immediately before the patching material is placed.

21.12 **Use of Epoxy**

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of Engineer. Epoxies shall be applied in strict accordance with the instructions of the manufacturer.

21.13 **Method of Repair**

21.13.1 Small size holes having surface dimensions about equal to the depth of the hole, holes left after removal of form bolts, grout insert holes and slots cut for repair of cracks shall be repaired as follows. The holes to be patched shall be roughened and thoroughly soaked with clean water until absorption stops. A 5 mm thick layer of grout of equal parts of cement and sand shall be well brushed into the surface to be patched, followed immediately by the patching concrete which shall be well consolidated with a wooden float and left slightly proud of the surrounding surface. The concrete patch shall be built up in 10 mm thick layers. After an hour or more, depending upon weather conditions, it shall be worked off flush with a wooden float and a smooth finish obtained by wiping with hessian, a steel trowel shall be used for this purpose. The mix for patching shall be of the same materials and in the same proportions as that used in the concrete being repaired, although some reduction in the maximum size of the coarse aggregates may be necessary and the mix shall be kept as dry as possible.

21.13.2 Mortar filling by air pressure (guniting) shall be used for repair of areas too large and/or too shallow for patching with mortar. Patched surfaces shall be given a final treatment to match the colour and texture of the surrounding concrete. White cement shall be substituted for ordinary cement, if so directed by Engineer, to match the shade of the patch with the original concrete.

21.14 **Curing of Patched Work**

The patched area shall be covered immediately with an approved non-staining, water-saturated material such as gunny bags which shall be kept continuously wet and protected against sun and wind for a period of 24 hours. Thereafter, the patched area shall be kept wet continuously by a fine spray or sprinkling for not less than 10 days.

21.15 **Approval by Engineer-in-Charge**

All materials, procedures and operations used in the repair of concrete and also the finished repair work shall be subject to the approval of Engineer. All fillings shall be tightly bonded to the concrete and shall be sound, free from shrinkage cracks after the fillings have been cured and dried.

21.16 **Finishing**

This specification is intended to cover the treatment of concrete surfaces of all structures.

21.16.1 **Finish for Formed Surfaces**

The type of finish for formed concrete surfaces shall be as follows, unless otherwise specified by the Engineer.

For surfaces against which backfill or concrete is to be placed, no treatment is required except repair of defective areas.

For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper application of the waterproofing material which is specified for use.

Unless specified, surfaces which will be exposed when the structure is in service shall receive no special finish, except repair of damaged or defective concrete, removal of fins and abrupt irregularities, filling of holes left by form ties and rods and clean up of loose or adhering debris.

21.16.2 **Standard Finish for Exposed Concrete**

The standard finish for exposed concrete shall be a smooth finish.

A smooth finish shall be obtained with the use of lined or plywood forms having smooth and even surfaces and edges. Panels and form

linings shall be of uniform size and be as large as practicable and installed with closed joints. Upon removal of forms the joint marks shall be smoothened off and all blemishes, projections, etc. removed leaving the surfaces reasonably smooth and unmarred.

21.16.3 **Integral Cement Concrete Finish**

An integral cement concrete finish of specified thickness for floors and slabs shall be applied either monolithic or bonded, as per I.S. 2571. The surface shall be compacted and then floated with a wood float or power floating machine. The surface shall be tested with a straight edge and any high and low spots eliminated. Floating or trowelling of the finish shall be permitted only after all surface water has evaporated. Dry cement or a mixture of dry cement and sand shall not be sprinkled directly on the surface of the cement finish to absorb moisture or to stiffen the mix.

21.16.4 **Rubbed Finish**

A rubbed finish shall be provided only on exposed concrete surfaces. Upon removal of forms, all fins and other projections on the surfaces shall be carefully removed, offsets leveled and voids and/or damaged sections immediately saturated with water and repaired by filling with a concrete or mortar of the same composition as was used in the surface. The surfaces shall then be thoroughly wetted and rubbed with carborundum or other abrasive. Cement mortar may be used in the rubbing, but the finished surfaces shall not be brush coated with either cement or grout after rubbing. The finished surfaces shall present a uniform and smooth appearance.

21.16.5 **Protection**

All concrete shall be protected against damage until final acceptance by Engineer/Purchaser.

22.0 **FORMWORK**

All formwork shall be made mortar proof and sufficiently strong and well anchored to withstand the loads they have to bear without any distortion. Before constructing forms, the Contractor, if required, shall submit detailed drawings and design, wherever necessary in critical areas of proposed formwork for examination by the Engineer. Safety against buckling of any member shall be investigated in all cases. If such drawings are not satisfactory to the Engineer, the Contractor shall make such changes as may be required prior to start of the work. The Engineer's approval of the drawings as submitted, or as corrected shall in no way relieve the Contractor of his

responsibility for adequately designing, constructing and maintaining forms and the safety of formwork so that they will function properly under applicable conditions of work.

The formwork shall consist of shores, bracings, sides of beams and columns of slabs etc. including ties, anchors, hangers, inserts etc. complete which shall be properly designed and planned for the work. False work shall be so constructed that vertical adjustments can be made to compensate for take up and settlements. Wedges may be used at the top or bottom of timber shores, but not at both ends, to facilitate vertical adjustment or dismantling of the formwork.

22.01 **Design of Formwork**

22.01.1 The design and engineering of the formwork as well as its construction shall be the responsibility of Contractor. If so instructed, the drawings and/or calculations for the design of the formwork shall be submitted to Engineer for approval before proceeding with work, at no extra cost to Purchaser. Engineer's approval shall not however relieve Contractor of the full responsibility for the design and construction of the form work. The design shall take into account all the loads vertical as well as lateral, that the forms will be carrying including live and vibration loadings.

22.01.2 The vertical loads assumed shall consist of the dead load plus allowance for live load. The weight of formwork together with weight of freshly placed concrete is considered dead load. The live load consists of the weight of workmen, equipment, runways, and impact and will be taken as not less than 400 kg/m2 of horizontal projection.

22.01.3 Forms, ties, and bracing must be designed for a lateral pressure of fresh concrete of maximum of 10 to 15 tonnes/m2 unless higher loads are likely to occur in any special cases as may be specified on the drawings. Braces and shores must be designed to resist all possible lateral loads such as wind, cable tensions inclined supports, dumping of concrete, and starting and stopping of equipment. In no case should the assumed value of lateral load due to wind, dumping of concrete and equipment acting in any direction at each floor line be less than 150 kg/metre of floor edge or two (2) percent of total dead load of the floor, whichever be greater. Wall forms should be designed for maximum wind load atleast 50kg/m2 and bracing for wall forms shall be designed for a lateral load of atleast 150 kg/metre of wall applied at the top.

22.01.4 The formwork must be designed for any special conditions of construction likely to occur, such as unsymmetrical placement of concrete, impact of machine delivered concrete, uplift, and concentrated load. Imposition of construction load on the partially completed structure shall not be allowed.

22.01.5 A design analysis will not be required for formwork for structures less than five (5) metres in height if all loads are transmitted directly to the ground by vertical supports. However, safety against buckling of any member shall be investigated in all cases. For heavy construction and for all other cases, design analysis shall be made and got approved by the Engineer. The formwork system shall be designed to transfer all lateral loads to the ground in such a manner as to ensure safety at all times. Diagonal bracing shall be provided in vertical and horizontal planes where required to provide stiffness and to prevent buckling of individual members.

22.01.6 Before constructing forms, the Contractor, if required, shall submit detailed drawings of proposed formwork for examination by the Engineer. If such drawings are not satisfactory to the Engineer, the Contractor shall make such changes as may be required prior to start of work. Although the Contractor shall be responsible for the design, construction and safety of formwork, the formwork design shall be subject to the approval of the Engineer. The Engineer's approval of the drawings as submitted, or as corrected in no way shall relieve the Contractor of his responsibility for adequately construction and maintaining the forms so that they will function properly under applicable conditions of work including emergent conditions.

22.01.7 The internal dimensions of the forms shall conform precisely to the structure to be built; they shall have smooth surfaces and their corners shall be rounded with 20mm side triangular wooden stats, unless otherwise specified on drawings. Forms shall be sufficiently rigid to hold without distortion the fresh concrete, the vibrations ensuing from transit and distribution of the concrete, with a minimum factor of safety of 2.0.

22.01.8 Beam forms shall be provided with ties to avoid horizontal distortion; formwork for columns shall be reinforced with square braces and those of considerable cross-section or height shall be bound with spirals of twisted wire.

22.01.9 All forms shall be generously nailed; boards for slab work shall have atleast two (2) nails on such supporting tie-rod. Boards shall be of uniform thickness; edges shall be at right angles and smooth for easy jointing.

22.01.10 The number of supports shall be such as to safely support the loads specified; the Engineer may demand that their number be increased whenever it is considered necessary. A load-spreading plate shall be placed on the top of the supports; their base shall rest on a dual wooden wedge arrangement.

22.01.11 Prior to the concreting and after concreting, the exposed surfaces of the shuttering or moulds shall be cleaned of all adhering concrete before depositing of fresh concrete. Details of construction joints shall be arranged so that a 'Starter' is provided to which the forms for the next pour can be tightly clamped and suitable baulking shall be used to prevent leakage of grout from the concrete.

22.01.12 Wherever concreting of narrow members is required to be carried out within forms of considerable depth temporary openings in the sides of the forms shall, if so directed by the Engineer, be provided to facilitate the pouring and consolidation of concrete.

22.01.13 Small temporary openings shall be provided if necessary at the bottom of forms for columns and beams to permit the expulsion of rubbish etc. Shuttering must be used for all slopes exceeding 15 degrees to the horizontal, to enable the concrete to be properly rammed.

22.01.14 No load shall be put or any weight suspended from slabs, for one month after casting and temporary props shall be left in for the support of the under-side of slabs, beams etc. for as long as is reasonably practicable after stripping of shuttering.

22.01.15 No shuttering or temporary props shall be removed without permission being obtained from the Engineer and being recorded in the Contractor's Log Book under the Engineer's signatures.

22.01.16 Form stripping shall be performed slowly and gradually. No shuttering or temporary props shall be removed without permission being obtained from the Engineer and being recorded in the Contractor's Log Book under the Engineer's signatures.

22.01.17 The form work in contact with concrete shall be clean and well coated with mould oil. Mould oil used shall be insoluble in water. non-staining and not injurious to concrete. It shall not become flaky or be removed by water.

## 22.2 Tolerances

Tolerance is specified permissible variation from lines, grade or dimensions. No tolerances specified for horizontal or vertical building lines or footing shall be construed to permit encroachment beyond the legal boundaries. Unless otherwise specified, the following tolerance will be permitted.

### 22.2.1 Tolerance for Reinforced Concrete Works:

a) Deviation from specified dimension of cross section of column & beam — - 6 mm, + 12 mm

b) Deviation from dimension of footing

i) Dimension in plan — - 12 mm, + 50 mm

ii) Eccentricity — 0.02 times the width of the footing in the direction of deviation but not more than 50 mm.

iii) Thickness — ±0.05 times the specified thickness

22.2.2 **Tolerances for reinforcement bars :**

| Description | Permissible Max. Deviation (mm) | |
|---|---|---|
| | Plus | Minus |
| Placing of reinforcement : | | |
| **- For effective depth 200mm or less** | +10 | -5 |
| - For Effective depth more than 200mm | +15 | -10 |
| Cover to reinforcement : | - | -5 |
| Cutting of reinforcement : | | |
| - When minimum length specified | +75 | - |
| - When maximum length specified | - | - |
| - When maximum or minimum length not specified | +75 | -25 |

22.2.3 **Tolerances in fixing anchor bolts :**

i) Anchor bolts without sleeves ± 1.5 mm in plan

ii) Anchor bolts with sleeves ± 5.0 mm in elevation

a) For bolts upto & including 28 mm dia ± 5 mm in all directions

b) For bolts 32 mm dia and above ±3 mm in all directions

iii) Embedded Parts - ± 5 mm in all directions

22.2.4 **Dimensional Tolerance for formwork**

| | | |
|---|---|---|
| Levels and heights | - | ±6mm<br>3mm for every metre subject to a maximum of 10mm |
| Unevenness of any surface | - | ±3mm |
| Length / breadth | - | ±12mm |
| Diagonal | - | ±15mm |

In case of inclined surfaces, the deviation in the alignment of inclined surfaces, shall not exceed 3mm with reference to the theoretical alignment, for a length of 1000mm measured vertically, subject to a maximum of 10mm.

22.3 **Type of Formwork**

Formwork may be of steel plate/plywood. For special finishes the formwork may be lined with plywood, special, oil tempered hard board, etc. Sliding forms and slip forms may be used with the approval of Engineer.

22.4 **Formwork Requirements**

22.4.1 Forms shall conform to the shapes, lines, grades and dimensions including camber of the concrete as called for on the drawings. Ample studs, walers, braces, ties, straps, shores, etc. shall be used to hold the forms in proper position without any distortion whatsoever until the concrete has set sufficiently to permit removal of forms. Forms shall be strong enough to permit the use of immersion vibrators. In special cases form vibrators may also be used. The shuttering shall be close boarded. Timber shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps or other surface defects in contact with concrete. Faces coming in contact with the concrete shall be free from adhering grout, plaster, paint projecting nails, splits or other defects. Joints shall be sufficiently tight to prevent loss of water and fine material from concrete.

22.4.2 Steel plate shuttering shall be used below 0.0 m level for all the concrete structures. Any structure above 0.0 m level and where plastering is not envisaged and for all water proof structures even below 0.0 m level plywood shuttering shall be used.

22.4.3 All new and used form lumber shall be maintained in a good condition with respect to shape, strength, rigidity, water tightness, smoothness and cleanliness of surfaces. Form lumber unsatisfactory in any respect shall not be used and; if rejected by Engineer, shall be removed from the Site.

22.4.4 Shores supporting successive storeys shall be placed directly over those below or be so designed and placed that the load will be transmitted directly to them. Trussed supports shall be provided for shores that cannot be secured on adequate foundations.

22.4.5 Formwork, during any stage of construction showing signs of distortion or distorted to such a degree that the intended concrete work will not conform to the exact contours indicated on the drawings, shall be repositioned and strengthened. Poured concrete affected by the faulty formwork, shall be removed in its entirety and the formwork corrected prior to placing new concrete.

22.4.6 Excessive construction camber to compensate for shrinkage, settlement, etc. that may impair the structural strength of members will not be permitted.

22.4.7 Forms for substructure concrete may be omitted when in the opinion of Engineer the open excavation is firm enough to act as the form. Such excavations shall be slightly larger than required by the drawings to compensate for irregularities in excavation and to ensure the design requirements.

22.4.8 Forms shall be so designed and constructed that their removal will not damage the concrete. Face formwork shall provide true vertical and horizontal joints, conform to the architectural features of the structure as to location of joints and be as directed by Engineer.

22.4.9 Where exposed smooth or rubbed concrete finishes are required the forms shall be constructed with special care so that the resulting concrete surfaces require a minimum finish.

## 22.5 Bracings, Struts and Props

Shuttering shall be braced, strutted, propped and so supported that it shall not deform under weight and pressure of the concrete and also due to the movement of men and other materials. Bamboos shall not be used as props or cross bearers.

The shuttering for beams and slabs shall be so erected that the shuttering on the sides of the beams and under the soffit of slabs can be removed without disturbing the beam bottoms. Repropping of beams shall not be done except when props have to be reinstated to take care of construction loads anticipated to be in excess of the design load. Vertical props shall be supported on wedges or other measures shall be taken whereby the props can be gently lowered vertically while striking the shuttering. If the shuttering for a 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 proceeds, or windows may be left for pouring concrete from the sides to limit the drop of concrete to 1.0 M or as directed by Engineer.

22.6 **Mould Oil**

Care shall be taken to see that the faces of form work coming in contact with concrete are perfectly cleaned and two coats of mould oil or any other approved material applied before fixing reinforcement and placing concrete. Such coating shall be insoluble in water, non-staining and not injurious to the concrete. It shall not become flaky or be removed by rain or wash water. Reinforcement and/or other items to be cast in the concrete shall not be placed until coating of the forms is complete. Adjoining concrete surfaces shall also be protected against contamination from the coating material.

22.7 **Chamfers and Fillets**

All corners and angles exposed in the finished structure shall be formed with mouldings to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise specified, shall be 20 mm x 20 mm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be planed or surfaced to the same texture as the forms to which it is attached.

22.8 **Vertical Construction Joint Chamfers**

Vertical construction joints on faces which will be exposed at the completion of the work shall be chamfered as above except where not permitted by Engineer for structural or hydraulic reasons.

22.9 **Wire Ties**

Wire ties passing through the walls shall not be allowed. In their place bolts passing through sleeves shall be used.

22.10 **Reuse of Forms**

Before reuse, all forms shall be thoroughly scrapped, cleaned, nails removed, holes that may leak suitably plugged and joints examined and when necessary, repaired and the inside retreated to prevent adhesion, to the satisfaction of Engineer. Warped lumber shall be resized. Contractor shall equip himself with enough shuttering to complete the job in the stipulated time.

22.11 **Removal of Forms**

22.11.1 Contractor shall record on the drawing or a special register the date upon which the concrete is placed in each part of the work and the date on which the shuttering is removed therefrom.

22.11.2 In no circumstances shall form be struck until the concrete reaches a strength of at least twice the stress due to self weight and any construction/erection loading to which the concrete may be subjected at the time of striking form work.

22.11.3 In normal circumstances (generally where temperatures are above 20 $^{0}$ C forms may be struck after expiry of the following periods:

| | | **Ordinary Portland Cement concrete** |
|---|---|---|
| a) | Walls, columns and vertical sides of beams | 24 to 48 hours as directed by the Engineer-in-Charge |
| b) | Slabs (Props left under) | 3 days |
| c) | Beam sofits (Props left under) | 7 days |
| d) | Removal of props to slabs: | |
| | i) Spanning upto 4.5 m | 7 days |
| | ii) Spanning over 4.5 m | 14 days |
| e) | Removal of props under Beams | |
| | spanning upto 6m | 14 days |
| | spanning over 6m | 21 days |
| f) | Cantilever slabs | 14 days |

22.11.4 Striking shall be done slowly with utmost care to avoid damage to arises and projections and without shock or vibration, by gently easing the wedges. If after removing the form work, it is found that timber has been embedded in the concrete, it shall be removed and made good as specified earlier.

22.11.5 Reinforced temporary openings shall be provided, as directed by Engineer, to facilitate removal of formwork which otherwise may be inaccessible.

22.11.6 Tie rods, clamps, form bolts, etc. which must be entirely removed from walls or similar structures shall be loosened not sooner than 24 hours nor later than 40 hours after the concrete has been deposited. Ties, except those required to hold forms in place, may be removed at the same time. Ties, withdrawn from walls and grade beams shall be pulled toward the inside face. Cutting ties back from the faces of walls and grade beams will not be permitted.

## 23.0 FOUNDATION BEDDING, BONDING AND JOINTING

All surfaces upon or against which concrete will be placed shall be suitably prepared by thoroughly cleaning, washing and dewatering as Engineer may direct, to meet the various situations encountered in the work.

Soft or spongy areas shall be cleaned out and back filled with either a approved soil from borrow areas / stock pile, lean concrete or clean sand fill compacted to a minimum density of 90% Modified Proctor, Unless otherwise mentioned in Schedule of Quantities.

### 23.01 Preparation of Earth Strata for Foundations

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft, yielding soil shall be removed and replaced with suitable earth well compacted as directed by Engineer. Where specified, lean concrete shall be provided on the earth stratum for receiving concrete.

### 23.02 Preparation of Concrete Surfaces

The preparation of concrete surfaces upon which additional concrete is to be placed later shall preferably be done by scarifying and cleaning while the concrete is between its initial and final set. This method shall be used wherever practicable and shall consist of cutting the surface with picks and stiff brooms and by use of an approved combination of air and water jets as directed by Engineer.

When it is not practicable to follow the above method it will be necessary to employ air tools to remove laitance and roughen the surface.

The final required result shall be a pitted surface from which all dirt, unsound concrete, laitance and glazed mortar have been removed.

## 24.0 PLACING CONCRETE UNDERWATER

Under all ordinary conditions all foundations shall be completely de-watered and concrete placed in the dry. However, when concrete placement under water is necessary all work shall conform to IS:456 and the procedure shall be as follows:

24.1 **Method of Placement**

Concrete shall be deposited underwater by means of tremies, or drop bottom buckets of approved type.

24.2 **Direction, Inspection and Approval**

All work requiring placement of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. All underwater concrete shall be placed according to the plans or specifications and as directed and approved by Engineer.

25.0 **SLOTS, OPENINGS, ETC**.

Slots, openings or holes, pockets etc. shall be provided in the concrete work at required location or as directed by Engineer. Any deviation from the approved drawings shall be made good by Contractor at his own expense, without damaging any other work. Sleeves, bolts, inserts, etc. shall also be provided in concrete work where so specified.

26.0 **GROUTING**

26.1 **Standard Grout**

26.01.1 The proportions of grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. The grout proportions shall be limited as follows:

| | Use | Grout Thickness | Mix Proportions | W/C Ratio |
|---|---|---|---|---|
| a) | Fluid Mix | Under 25 mm | One part Portland Cement to one part of sand | 0.44 |
| b) | General | 25 mm and over but less than 50 mm | One part Portland cement to 2 parts of sand | 0.53 |
| c) | Stiff Mix | 50 mm and over | One part of Portland cement to 1 parts of sand and 2 parts of coarse aggregate with 12mm or down chips | 0.53 |

26.01.2 a) Sand shall be such as to produce a flowable grout without any tendency to segregate.

b) Sand, for general grouting purposes, shall be graded within the following limits:

| | |
|---|---|
| Passing IS 2.36 mm sieve | 95 to 100% |
| Passing IS 1.18 mm sieve | 65 to 95% |
| Passing IS 300 micron sieve | 10 to 30% |
| Passing IS 150 micron sieve | 3 to 10% |

c) Sand for fluid grouts, shall have the fine material passing the 300 and 150 micron sieves at the upper limits specified above.

d) Sand, for stiff grouts, shall meet the usual grading specifications for concrete.

26.01.3 a) Surfaces to be grouted shall be thoroughly roughened and cleaned of all foreign matter and liatance.

b) Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material. The use of hot, strong caustic solution for this purpose will be permitted.

26.01.4 a) Prior to grouting, the hardened concrete surfaces to be grouted shall be saturated with water.

b) Water in anchor bolt holes shall be removed before grouting is started.

26.01.5 Forms around base plates shall be reasonably tight to prevent leakage of the grout.

26.01.6 Adequate clearance shall be provided between forms and base plate to permit grout to be worked properly into place.

26.01.7 Grouting, once started, shall be done quickly and continuously to prevent segregation, bleeding and break-down of initial set. Grout shall be worked from one side of one end to the other to prevent entrapment of air. To distribute the grout and to ensure more complete contact between base plate and foundation and to help release entrapped air link chains can be used to work the grout into place.

26.01.8 Grouting through holes in base plates shall be by pressure grouting.

## 27.0 SPECIAL NON-SHRINKING GROUT

27.01.1 Proprietory material of approved manufacture used as an admixture to obtain non-shrinking grout shall be mixed in the proportion of 1:1:1 (1 cement:1 admixture: 1sand), or as per manufacturer's instructions.

27.01.2 Pre-mixed non-shrinking grout of approved manufacture shall be used, all as per manufacturer's instructions and without any additional materials/admixtures such as cement, sand and aggregates etc.

## 28.0 PRE-MOULDED BITUMINOUS JOINT FILLER AND SEALING COMPOUND

28.01 Pre-moulded joint fillers shall be of non-deteriorating and resilient type conforming to IS:1834. Sealing compound shall be of Grade 'A' as per IS:1834. Bitumen primer shall conform to IS:3384.

28.02 The concrete surface shall be made clean, smooth and free from dirt or loose particles. When the surface is completely dry a coat of hot blown bitumen conforming to IS:702 of grade 85/25 shall be given with brush or spray.

28.03 When the bitumen is still hot the premoulded joint filler fibre board shall be pressed against the surface held in position till the time it automatically remains fixed in position. Where the joint filler has been specified in two layers, the second board will be fixed on the board fixed as above with a few tacking patches to bitumen between the two. After placing the filler in position, the surface of the filler against which further concreting is to be done is given a coat of bitumen.

28.04 Before application of the sealing compound the joints are splayed or brushed with bitumen primer. The primer is then allowed to dry thoroughly for atleast 24 hours and then mixed with a mixture of 30% fine sand and 70% sealing compound by weight.

## 29.0 STRUCTURAL WATER PROOFING

29.01 Waterproofing work shall be carried out by a firm of specialists in the trade approved by the Engineer.The Contractor shall guarantee the water proofness of the underground RCC structure for a period of ten (10) years after the certified completion and handing over the same to the Engineer.

29.02 The site shall be kept dry by adequate arrangement for pumping out water till the waterproofing work has been completed.

29.03 Two coats of slurry coating of approved polymer modified cementitious composite as per manufacturer's specifications shall be applied over the mud mat (rendered

smooth with 20mm thick cement plaster 1 cement : 3 sand admixed with approved water proofing compound).

29.04 Threaded G.I. nozzles 12mm diameter (Nominal Bore) and or suitable length shall be placed & fixed in an approximate grid pattern of 1.50m center to center on the entire base slab and walls prior to or during concreting. Nozzles shall be kept flush with the top surface of base slab & inside faces of walls. Similar nozzles shall also be provided at regular intervals (not exceeding 1.50m apart) atleast 300mm above the construction joints (where such joints are permitted or shown in the drawings) and at critical points as directed by the Engineer. Nozzles shall be kept plugged at both ends to prevent them from getting clogged by concrete.

30.00 **GUNITING / SHOTCRETING**

30.01 Generally shotcreting shall be done in accordance with IS:9102. Guniting of RCC members, where specified shall be with an intimate mixture of cement, sand (or fine aggregate) and water. This mixture is forced or ejected through a cement gun and shot into place by compressed air. Uniformly graded, thoroughly mixed dry materials, with low water / cement ratio are charged into the gun and shot under pressure by compressed air. Sand shall be slightly moist to works better., The usual proportions of cement and fine aggregate are 1:3. The fine aggregate should be will graded upto a maximum size of 10mm, preferably 4.75mm downwards.

30.02 Reinforcement for shotcreting shall be as detailed below, unless specified otherwise.

a) Reinforcement in one direction consisting of 6mm MS bars at 750mm c/c shall be connected to the lugs for fastening of the wire fabric. This shall be used in case of 50mm or above thick shotcreting.

b) Wire fabric conforming to IS:1566 shall be used as reinforcement and shall consist of wire, 3mm diameter, spaced 50mm both ways and shall be electrically cross welded. Wire fabric shall be securely tied to 6mm bars for 50mm thickness. Adjacent sheet of wire fabric shall be lapped at least 100mm and tied.

c) Clear cover to reinforcement mesh shall not be less than 15mm.

**31.00** ANCHOR BOLTS

**31.01 Supply, fabrication, erection and installation of foundation bolts assembly shall comprise of foundation bolts, stiffener plates, washers, nuts, lock, nuts, pipe sleeves etc.**

**31.02 MATERIALS**

**31.02.01 Foundation bolts shall generally conform to IS:5624. Mild steel bars used for the fabrication of bolt assembly shall conform to grade -1 of IS:432, IS:2062 or any other material including high carbon / high tensile steel as specified.**

**31.02.02 Hexagonal nuts and lock nuts shall conform to IS:1363 & IS:1364 upto M 36 dia and IS:3138 for M42 to M150 dia. Flat plain washers shall be of mild steel and punched / machined type conforming to IS:5369. Steel pipe sleeves shall conform to Medium class of IS:1161.**

**31.03 FABRICATION, ERECTION, ETC.**

**31.03.01 The fabrication and erection of bolt assemblies shall include threading, cutting, grinding, drilling, welding, etc. complete. All bolts, bolt assemblies etc. shall be fabricated by the Contractor to the correct dimensions and shapes as shown on drawings, supplied by the Engineer. The bolts shall have coarse pitch screw thread in the diameter range, 8 to 64 mm and 6mm pitch screw for diameter >64 mm as per IS:4218.**

**31.03.02 For fabrication of any particular size of bolt indicated on the drawing, the diameter of the threaded portion of the bolt shall be considered as the diameter of the bolt.**

**31.02.03 Fabrication & erection shall be carried out as per IS:800. Welding shall conform to IS:816 and IS:9595.**

31.02.04 Every bolt shall be provided with a steel washer under the nut. The washer shall be flat and minimum outside inscribed circle have a diameter 2.50 times that of the bolt and of suitable thickness. All nuts shall be of Every bolt shall be provided with a steel washer, under the nut. The washer shall be flat steel with well formed hexagonal heads, unless specified otherwise, forged from solid metal and shall be dipped in hot boiled linseed oil as soon as these are made. The nuts shall fit good on the bolts.

31.02.05 During erection, the Contractor shall provide necessary template, temporary bracings, supports etc to ensure popper positioning of the assemblies and holding them firmly until they are cast / grouted and the grout has set. All materials shall be erected in plumb and in level (unless otherwise specified) and at true locations as shown on the drawings. Threads shall be protected by using PVC tape.

**32.00** ENCASEMENT OF STEEL STRUCTURES / ELEMENTS

**32.01 GENERAL REQUIREMENTS**

**32.01.01 All concrete work, reinforcement, formwork and staging work shall be done as per stipulations in the relevant sections of this specification.**

**32.01.02 The reinforcement to be provided for encasement of steel elements shall be mild steel bars or in the form of wire netting. Such reinforcement shall be kept 20 mm away from the steel member and held securely to it.**

**32.01.03 The minimum grade of concrete to be used for encasing shall be M-20 unless specified. The aggregate to be used in concrete shall be 12.5 mm maximum size unless specified otherwise. In case of box type steel sections, encasement shall be done with cement sand mortar (1:4) with thickness of 50mm over 0.9mm size wire netting conforming to IS:3150, or as shown on the drawings.**

**32.01.04 In the case of encasement of beams with concrete, if the gap between the edge of the shuttering and flange is hardly sufficient for placing the concrete, the workability of the concrete shall be increased suitably by increasing the water cement ratio.**

**32.01.05 Minimum cover for concrete encasement shall be 50mm.**

**32.02 MATERIALS**

**32.02.01 The materials shall be in accordance with the relevant clauses of Technical Specification for Properties, Storage and handling of common Building Materials which shall be deemed to form the part of this specification. Hexagonal wire netting shall be 0.9 mm dia and 19mm aperture size, conforming to IS:3150.**

33.00 **INSERTS AND CUTOUTS IN CONCRETE WORKS**

33.01 Numerous inserts are required to be fixed/embedded as indicated in construction drawings/as directed by Engineer in various civil works and other miscellaneous equipment foundations and works. These inserts comprise plates, angles, pipe sleeves, anchor bolt assemblies etc. While most of the inserts will be supplied by owner, free of cost at his stores, for incorporation in the works, certain inserts are required to be fabricated by the tenderer. These would be indicated clearly on the construction drawings.

33.02 The rate quoted by the tenderer for placing in position of inserts shall hold good for accurately fixing the inserts at the correct levels/alignment and shall include for

the cost of any temporary or permanent supports/anchors such as bars including cutting, bending, welding etc. as required.

33.03 Steel templates shall be used by Contractor to locate and very accurately position bolts, group of bolts, inserts, embedded parts etc. at his cost. Such templates shall be got previously approved by the Engineer. Templates shall invariably be supported such that the same is not disturbed due to vibration, movement of labourers, materials, shuttering work, reinforcement etc. while concreting. The contractor will have to suitably bend, cut or otherwise adjust the reinforcement in concrete at the locations of inserts as directed by the Engineer. If the Engineer so directs, the inserts will have to be welded to reinforcement to keep them in place. Contractor shall be responsible for the accuracy of dimensions, levels, alignments and centre lines of the inserts in accordance with the drawings and for maintenance of the same until the erection of equipment/structure or final acceptance by Owner.

33.04 Contractor shall ensure proper protection of all bolts, inserts, etc. from weather by greasing or other approved means such as applying white lead putty and wrapping them with gunny bags or canvas or by other means as directed by Engineer to avoid damage due to movement of his labourers, material, equipment, etc. No extra claim from the contractor on this account shall be entertained. Contractor shall be solely responsible for all the damages caused to bolts, inserts, etc. due to his negligence and in case damages do occur, they shall be rectified to the satisfaction of Engineer at the Contractor's cost.

33.05 Cutouts, chamfers, pockets, etc shall be left as indicated in the drawings and no extra cost shall be payable for providing these at correct locations. Contractor shall take all necessary precautions to protect the cutouts from accidentally getting filled up or the edges getting broken.

## 34.00 WATER STOPS

34.01 PVC/Rubber water stops of the width and type as specified on the drawings shall be of approved manufacture and prior approval of the Engineer shall be obtained by the Contractor before procurement and incorporation in the works.

34.02 Water stops shall be cleaned before placing them in position. Any dirt/grease shall be removed using water/detergent as directed by Engineer. Water stops shall be procured in long lengths as supplied by manufacturer to avoid joints as far as possible. Standard intersection pieces shall also be procured depending on the requirement. Splicing/Jointing and installation of water stops shall be done as per manufacturer's instructions. Projecting portions of water stop shall be thoroughly cleaned of all mortar/concrete coatings as directed by Engineer before resuming further concrete work.

## 35.00 PRE-CAST CONCRETE WORKS

35.01 Precast concrete shall comply with IS:456 and with the following requirements.

35.02 All precast units shall be cast on a suitable bed or platform with firm foundation and free from wind. Contractor shall be responsible for the accuracy of the level or shape of the bed or platform. A suitable serial number and date of casting shall be impressed and painted on each units.

35.03 **Striking Forms**

Side shutters shall be struck in less than 24hours after depositing concrete and no precast unit shall be lifted until the concrete reaches a strength of least twice the stress to which the concrete may be subjected at the time of shifting.

35.04 **Handling**

The lifting and removal of precast units shall be undertaken without causing shock, vibration or undue bending stress. Before lifting and removal take place contract shall satisfy the Engineer or his representative that the methods proposed to be adopted for these operations will not overstress or otherwise affect seriously the strength of the precast units. The reinforcement side of the units shall be distinctly marked.

All slabs shall have a standard approved width, except when specially required for the geometry of the work. All slabs shall be unwrapped, free from cracks and broken edges. Defective pieces shall be rejected. Hole and opening shall be provided during casting or cut afterwards as required, without any extra changes. After installation of piers, vents, sleeves etc. the openings shall be plugged with concrete of original grade.

35.05 **Curing**

All precast shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered preferably be completely immersed in water.

36.00 **INSPECTION**

36.01 All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of Engineer.

36.02 All materials supplied by Contractor and all work or Construction performed by Contractor rejected as not in conformance with the specifications and drawings, shall be immediately replaced at no additional expense to the Purchaser.

36.03 Approvals of any preliminary materials or phase of work shall in no way relieve the Contractor from the responsibility of supplying concrete

and/or producing finished concrete in accordance with the specifications and drawings.

36.04 All concrete shall be protected against damage until final acceptance by Purchaser or his representative.

37.00 **CLEAN-UP**

37 01 Upon the completion of concrete work, all forms, equipment construction tools, protective coverings and any debris resulting from the work shall be removed from the premises.

37 02 All debris i.e. empty containers, scrap wood, etc. shall be removed to "dump" daily or as directed by Engineer.

37 03 The finished concrete surfaces shall be left in a clean condition satisfactory to Engineer.

**38.00** SAMPLING, TESTING & QUALITY CONTROL

Frequency of sampling and testing of various materials shall be as given in the table below :

| S. NO. | NATURE OF TEST / CHARACTERSTICS | METHOD OF TEST | NOS. OF SAMPLES & FREQUENCY OF TEST | REMARKS |
|---|---|---|---|---|
| **A** | **COARSE AGGREGATES :-** | | | |
| a. | Particle size | IS:2386(Pt-I) | One per 100 cum or part there of or change of source whichever is earlier | Result should be as per the requirement of design mix, subject to variations within the limits specified in relevant Indian Standards Codes. |
| b. | Moisture content | IS:2386(Part– | Oncefor each | Accordingly, water |

| | | | | |
|---|---|---|---|---|
| | | 3) | stack of 100 cum or part thereof except during monsoon when this has to be done every day before starting of the work. | content of the concrete shall be adjusted. |
| c. | Specific gravity, density, voids absorption | IS:2386(Part – 3) | Once in 12 weeks or change of source, which ever is earlier | These tests shall be carried out while establishing design mix and results to be intimated. |
| d. | Mechanical properties crushing value, abrasion value and impact value | IS:2386 (Part-IV) | Once per source | Acceptance norms shall be as per IS:383. |
| e. | Soundness | IS:2386(Part-V) | Once per source | Acceptance norms shall be as per IS:383. |
| f. | Reaction with acid and alkali | IS:2386 (Part-VII) | Once per source | These tests shall be carried out while establishing design mix and results to be intimated. |
| g. | Flakiness and petro graphic examinations | IS:2386 | This is to be done once and should be repeated in case, the source is charged. | These tests shall be carried out while establishing design mix and results to be intimated. |
| h. | Deleterious materials | IS:2385 (Part – II) | Once per source | Results should be within the limit as specified in relevant Indian Standard Codes and in this Specification. |
| **B.** | **FINE AGGRETGATES / SAND :** | | | |
| a. | Particle size and shape | IS:2386 (Part – I) | One per 100 cum or part thereof or | Should be as per the requirement of design |

| | | | | |
|---|---|---|---|---|
| | | | change of source, whichever is earlier | mix, subject to variation within the limits as specified in relevant IS Codes. |

| | | | | |
|---|---|---|---|---|
| b. | Specific gravity, density, voids, absorption and bulking | IS:2386 (Part – III) | Once in 12 weeks or change of source, whichever is earlier. | These tests will be carried out while establishing design mix and results to be intimated. |
| c. | Bulkage, moisture content (Routine test) | IS:2386 (Part – III) | To be done everyday before start of work | Volume of sand and weight of water shall be adjusted as per bulkage and moisture content. |
| d. | Silt, clay, deleterious materials, organic impurities | IS:2386 (Part – III) | Once per source and to be repeated if source is changed. | Acceptance norms shall be as per IS:383. |
| e. | Soundness and petrographic examination | IS:2386 (Part-5 and 8) | Once per source | Acceptance norms shall be as per IS:383. |
| f. | Mortar making properties | IS:2386 (Part-VI) | Once per source | Acceptance norms shall be as per IS:383. |
| g. | Reaction with acid and alkali | IS:2386 (Part-VII) | Once per source | Acceptance norms shall be as per IS:383 and IS:2386 (Part-7) |
| **C.** | **CEMENT :** | | | |
| a. | Received from supplier :<br><br>Setting time and compressive strength and all other tests as per relevant IS codes | IS:4031 | Once sample from each consignment | Acceptance norms shall be as per relevant Indian Standard Codes. |
| b. | If stored for more than 2<br><br>months of original | IS:4031 | Once sample from each lot of 100 t or part thereof / each | Acceptance norms shall be as per relevant Indian Standard Codes. |

| | | | | |
|---|---|---|---|---|
| | receipt :<br><br>Setting time and compressive strength as per relevant IS codes | | consignment | |
| c. | Ensure that cement is stored in covered storage on raised platform and weather proof conditions | Visual | 100 % | As per specifications |
| **D.** | **WATER :** | | | |
| | Harmful substances, pH value, initial setting time, compressive strength | IS:3025, IS:4031 & IS:456 | Once a month for each source | Acceptance norms shall be as per IS:456. |
| **E.** | **CONCRETE :** | | | |
| a. | Workability (Slump and compaction factor) | IS:1199 | One sample every two hours from every mixing plant | Acceptance value shall be as per Cl. 6.1 of IS:456 |
| b. | Crushing Strength | IS:516 | (i) As per Clause 14.2.2 IS:456 for initial period. | Acceptance value shall be as per Cl. 15 of IS:456 |
| | | | ii) One sample of six cubes per 150 cum or part thereof for mass concrete for subsequent period. | A minimum of 3 specimens / samples shall be tested for 28 days strength |
| c. | Water-cement ratio | IS:1199 | At random at the time of batching | According to mix design |
| d. | Cement content | IS:1199 | At random at the time of batching | According to mix design. |
| e. | Water tightness test retaining Structures | IS:3370 | Each tank or reservoir | Acceptance criteria as per specification. |

| | | | | |
|---|---|---|---|---|
| | | | | |
| f. | Finished dimensions | Physical measurement | All structures | Acceptance criteria as per specification. |
| **F.** | **FORM WORK :** | | | |
| a. | Staging (Durability, strength & soundness of staging, joint, adequacy of its foundation and specific level) | Visual | Each member | Any staging intended for use shall be approved by the Engineer for its durability and strength.<br><br>After erection of staging, nominated representatives of Engineer shall check the soundness of the staging as a whole, its joints, adequacy of its foundation & the specific levels. |
| **b.** | **Shuttering** | | | |
| i) | **Materials** | Visual | Random | Formwork materials shall be strictly as per specifications and approval of the Engineer Materials for formwork shall be unwarped, thoroughly clean and without broken or damaged edges either due to repetitive use or otherwise Oiling of form work before concreting shall be resorted to. |
| ii) | Joints | Visual | Random | Joints shall be leak-proof to avoid loss of liquid. |
| iii) | Dimensions and Plumb | Physical measurement | Each member and before every lift | Tolerance as per specifications |

| | | | | |
|---|---|---|---|---|
| G. | **REINFORCEMENT :** | | | |
| a. | Physical and chemical properties | Review of manufacturer's correlated test certificates | **Each lot** | These tests shall be consistency of the quality, grade and type of materials. |
| b. | Placement | Visual | 100 % | The bar bending schedule with the necessary hooks, laps covers,pacers and chairs shall be 100% checked for all concrete works before start of the work. |
| c. | Cutting tolerance | Physical examination | Random | Tolerance shall be as perspecification |
| d. | Freedom from defects | Visual | Random | Any of the bars selected for use shall be free from cracks, surface flaws, laminations and rough jagged and imperfect edges. |
| **H.** | **EMBEDDED PARTS :** | | | |
| a. | Type of embedment | Visual | Each part | Type / Details shall be as per drawings. Tolerance as per specification. |
| b. | Location and dimensions | Physical measurement | Each part | Details as per drawings. Tolerance as per specification. |

39.0 CPCI and ERBP treatment:

Protection of concrete work shall be ensured by adopting the following painting system:

1. Concrete Penetrating Bipolar Corrosion Inhibitor(CPCI)
2. Epoxide Resin Based Paint(ERBP)

The CPCI shall be applied first on concrete surface by brush or spray as per manufacturer's instruction. Subsequently, as per direction of Engineer-in-

charge, the ERBP shall be applied. The time lag between application of CPCI & ERBP shall be between five (5) and fifteen (15) minutes. The residual deposit of CPCI after migration of inhibitor in to the concrete shall be wiped with a cloth prior to 1st coat of ERBP application. The properties of the coated system shall conform to the various requirements of applicable ASTM standards viz. ASTM-D-217-68, B-117, D-4541, D-2794, G95 etc. the specifications for the application of these systems are given in clauses as under:

Sub-structure coating- Concrete Penetrating Bipolar Corrosion in inhibitor.

One coat of water based Concrete Penetrating Bipolar Corrosion Inhibitor (CPCI) shall be applied over the surface, irrespective of grade of concrete as per manufacturer's specifications to inhibit the corrosion process of embedded reinforcement bars. The CPCI shall be non-toxic with pH of minimum 9.5 and specific gravity 1.00 to 1.08. it shall be free from nitrite, chromates and phosphates and shall be dosed as per manufacturer's instructions. It shall have minimum 1 to 2 years successful usage history conforming to field validation and evaluation technique (ASTM G5-94, C-102-89, C-109-92, C-876-91).

Epoxide Resin Based Paint to Sub-structure-Elements:

Two(2) coats of Eposide Resin Based Anti-corrosive and chemical resistance paint over a coat of CPCI shall be applied as per manufacturer's instruction for protection of concrete against carbonation and chloride penetration in saline/marine environment. The primer coat shall be of grey color and topcoat shall be of black color with DFT of 150-162.5 microns each, thus giving the total DFT of 300-325 microns.

## Annexure-7
## SIS CODES & REFERENCES

1.1 All the Indian Standards referred to shall be the latest revision (including all amendments issued there to) at the time of execution.

1.2 Reference to only some of the codes in this document and various clauses of design criteria shall not limit or restrict the scope or applicability of other relevant codes. It shall be ensured that all other codes relevant to a specific job, in addition to those already mentioned, are followed wherever applicable.

1.3 Where British / American / DIN or other codes and standards are referred to in this document, equivalent Indian Standards may be substituted if available.

1.4 In case of any deviation / conflict between provisions of IS codes and the design criteria, the provisions that are more stringent shall followed unless specifically directed otherwise.

1.5 The Codes and Standards listed below are applicable for the design and construction of structures and buildings in general. Codes and Standards applicable for specific design and construction are listed elsewhere in reference sections.

1.6 Specifications for materials supplied from India follow the Indian Standard Specifications.

1.7 Field and laboratory testing procedures for materials follow Indian Standard Specifications.

1.8 Working stress design can be used as alternative but the approval of OWNER is a prerequisite.

1. **LOADS**

IS:875 Code of Practice for design loads ( other than earthquake ) for Buildings and structure (All parts )

IS:1911 Schedule of unit weights of building materials

IS:1893 Criteria for earthquake resistant design of structure

2. **FOUNDATIONS**

IS:1080 Code of Practice for design and construction of shallow foundations on soils ( other than raft, ring and shell )

IS:1904 Code of Practice for design and construction of foundations in soils general requirement

IS:2911 Code of Practice for design and construction of pile foundations: ( All parts )

IS:2950 Code of Practice for design and construction of raft foundations

IS:2974 Code of Practice for design and construction of machine foundations ( all parts )

IS:4091 Code of Practice for design and construction of foundations for transmission line towers and poles

IS:8009 Code of Practice for calculation of settlement of foundations: ( All parts )

IS:9556 Code of Practice for design and construction of diaphragm walls

IS:11089 Code of Practice for design and construction of ring foundation

IS:13301 Guidelines for vibration isolation for machine foundations

3. **RCC**

IS:456 Code of Practice for plain and reinforced concrete

IS:458 Specification for precast concrete pipes

IS:3370 Code of Practice for concrete structures for the storage of liquids: ( All parts )

IS:3414 Code of Practice for design and installation of joints in buildings

IS:3935 Code of Practice for composite construction

IS:4326 Code of Practice for earthquake resistant design and construction of buildings

IS:4995 Criteria for design of reinforced concrete bins for storage of granular ( all parts ) and powdery materials

IS:4998 Criteria for design of reinforced concrete chimneys: ( All parts)

IS:5525 Recommendation for detailing of reinforced concrete works

IS:1786 Specification for high strength deformed steel bars and wires for concrete reinforcement

IS:10262 Recommended guidelines for concrete mix design

IS:11384 Code of Practice for composite construction in structural steel and concrete

IS:11504 Criteria for structural design of Reinforced concrete Natural Draft Cooling Tower

IS:11682 Criteria for design of RCC staging for overhead water tanks

IS:13920 Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.

## 4. STRUCTURAL STEEL

IS:800 Code of Practice for general construction in steel

IS:802 Code of Practice for use of structural steel in overhead transmission line towers: (All parts)

IS:806 Code of Practice for use of steel tubes in general building construction

IS:808 Dimensions for hot rolled steel beam, column channel and angle section

IS:813 Scheme of symbols for welding

IS:816 Code of Practice for use of metal arc welding for general construction in mild steel

IS:1024 Code of Practice for use of welding in bridges and structures subjected to dynamic loading

IS:1161 Steel tubes for structural purposes

IS:2062 Structural steel ( fusion welding quality )

IS:4000 High Strength bolts in steel structures – Code of Practice

IS:7215 Tolerances for fabrication of steel structures

IS:8640 Recommendations for dimensional parameters for industrial building

IS:9178 Criteria for design of steel bins for storage of bulk material ( all parts )

IS:9595 Recommendation for Metal arc welding of carbon and carbon manganese steel

IS:12843 Tolerances for erection of steel structures

## 5. MISCELLANEOUS

IS:1038 Specification for steel doors, windows and ventilators

IS:1172 Code of basic requirements for water supply, drainage and sanitation

IS:1346 Code of Practice for water proofing of roofs with bitumen felts

IS:1742 Code of Practice for building drainage

IS:1905 Code of Practice for structural use of unreinforced masonry

IS:2210 Criteria for design of reinforced concrete shell structures and folded plates

IS:2470 Code of Practice for installation of septic tank: (part 1) Design criteria and construction

(part 2) Secondary treatment and disposal of septic tank effluent

IS:3067 Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings

IS:10440 Code of Practice for construction of reinforced brick and reinforced brick concrete floors and roofs

SP:6 Handbook for structural engineers (all parts)

SP:7 National Building Code of India

SP:16 Design Aids for reinforced concrete to IS:456-1978

SP:20 Handbook on masonry design and construction

SP:22 Explanatory handbook on codes for earthquake engineering ( IS:1982-1975 and IS:4326-1976 )

SP:24 Explanatory handbook on Indian Standard code of Practice for plain and reinforced concrete

SP:25 Handbook on causes and prevention of cracks in buildings

SP:32 Handbook on functional requirements of industrial buildings

SP:34 (SCIP) Handbook of concrete reinforcement and detailing

IRC:37 Guidelines for design of flexible pavements

IRC:73 Geometric design of roads

Bridge rules of Government of India, Ministry of Railways (Railway Board)

BS:4485 (part 4) Structural design of Cooling Towers

**Annexure-8**

DESIGN, ENGINEERING FOR CIVIL WORKS

PREQUALIFICATION

Prequalification Criteria for detail engineering of Civil Design works:-

The consultant should have prior experience in design of civil works associated with at least one bulk CHP and OHP of minimum capacity of 1000TPH covering the below mentioned areas within the preceding seven (7) years reckoned as on date of bid opening.

**I. R.C.C / CIVIL WORKS**

1. Double conveyor tunnel
2. Raft foundations & Pile foundations.
3. Minimum 4 no's substructure of wagon tippler.
4. Minimum 2 no's of track hopper of minimum 200M length.
5. ROADS , DRAINS
6. VIS supported crusher mounted R.C.C block.
7. Reclaim hopper
8. Underground transfer point.
9. Coal stock yard with drains for stock yard of not less than 400M construction.

PREPARATION AND REVIEW OF DESIGN DOCUMENTS/ DRAWINGS

Consultant should be capable of Designing and preparation of design documents / design drawings / civil drawings related to following areas of the Coal handling plant using latest Software tools for design and documentation. Necessary Civil assignment inputs related to various areas will be provided by BHEL. The consultant shall depute qualified design engineers within seven days from the date of LOI and shall clarity the design drawings/documents submitted to them if required in the premises of BHEL ISG, Bangalore. Suitable space will be provided for the engineers to work at BHEL office, whenever required. However the required computer/equipments, Design & Analysis software's, etc shall be arranged by consultant himself.

## SCOPE OF SERVICES

**Summary Scope –** Study of customer specification, Preparation of detailed civil drawings, participation in discussions. **And provide technical assistance during technical discussions** with contractors and customer for approval of drawing / documents etc. Visit to site for assistance to BHEL during construction work for solutions to design problems if any While executing the works, the consultant shall make efforts and ensure optimum design of the systems leading to saving in cost by BHEL and are leading to saving in completion time of the project meeting customer technical requirement and following the structural codes / good construction practices.

For designing the system, the plant plot plan, Track hopper, wagon Tippler details, conveyor profile and conveyor loading details, the crusher house profile, the Stock yard profile, the stacker reclaimer load details with civil assignment details, will be provided by BHEL

Major Buildings considered for design and consultancy in CHP & OHP as per Scope

### SCOPE OF WORK FOR DESIGN OF CIVIL ENGINEERING

**A- Scope Related to Civil consultant.**

The Consultant shall provide Design memorandum /Design data and complete Design documents of superstructure / substructure of CHP & OHP system including control building and auxiliary electrical facility**.**

**B- Scope Related to Civil Works**

1. Method of design/analysis, design parameters, various load details and critical load combinations, level of water table for design, maximum span limitations and slide /roller joint arrangement for conveyor trestle, TPs & Crusher House including vibro-isolation system, minimum size structural members, minimum grade of concrete, minimum thickness of concrete members, allowable stresses, method and sequence of construction including staging, details of proposed site testing facilities etc. strictly as per project requirement & specifications for the BHEL/ Owner's review and approval within 7 days from the date of receipt of the CHP & OHP conveyor profile and other load details..

2. Design data for civil works as mentioned below for various buildings of CHP & OHP:
   - i. Foundation details
   - ii. Brick works – internal and external
   - iii. Half brick thick wall
   - iv. One third brick thick wall
   - v. Damp proof course
   - vi. Plaster : exterior & rough side of interior brick wall

vii. Plaster of Paris punning
viii. Piling Works
ix. Stacker Reclaimers, CH, Junction tower, TPs, Conveyor Gallery & Trestle, Pipe & Cable Trestle, etc.
x. Cladding for conveyor gallery, TPs JNT, CH and other similar structures
xi. False ceiling
xii. Floor finish
xiii. Doors and windows
xiv. Rolling shutters
xv. Glazing
xvi. Roof
xvii. Painting
xviii. Stairs
xix. Rain water down covers & dust chutes
xx. Roads & Drains , culverts

3. The computer analysis/designs and a list of validated computer programs to be used by the contractor for the analysis and design.
4. The computer output listing requirements of all input data covering the loads and load combinations.
5. The various criteria required for design of various temporary works.
6. For temporary staging work the design calculations made on normally accepted practice for the structural forms etc.

**b- The consultant will render various technical services to BHEL/ ISG involving provision of basic documents for civil work:**

1. The Consultant shall provide the detailed technical specification for the following:
   1) Cement concrete (plain and reinforced)
   2) Concrete piles
   3) Roads, drains, pipe culverts, box culverts etc.

2. The consultant shall provide all necessary information including but not limited to following for the civil works and related indents and technical evaluation thereof :

   a- General plant layout drawing with coordinates of roads, buildings and facilities, piping/cable corridors, pipe and cable trestles and diversion roads and drains, equipment lay down areas etc.
   b- Structure / building wise civil assignment drawings, showing plan, elevation/section as required with complete load data for various loads and load combinations prepared by Mechanical vendor / their consultant.
   c- Site grading and storm water drainage study furnishing levels of various terraces arrangement and details of drains, culverts etc. for storm water drainage system.
   d- Floor plans, elevations, cross sections and perspective view of all buildings.
   e- Construction and erection procedure for all major structure with specific reference to main structure, transfer towers, conveyor galleries, CH, and other machine foundations of CHP & OHP.

f- Write up on various statutory requirements and their compliance for various buildings and facilities.
g- Interface with structures /building/services under other's scope / existing structures.
h- Recommendation of sequence of work to be followed during execution.
i- Minimum requirement of pedestals of steel columns, thickness of structural elements, guidelines on liquid retaining over ground/ underground structure.
j- Criteria for design and construction of equipment foundations.
k- Broad restrictions of technical requirement of conveyor galleries, trestles, CH, junction tower, and transfer points, control room / switchgear room etc.
l- Types of trenches, paving, fencing and approach roads, interconnecting roads, ponds and sewage water and waste water drainage system.
m- Details of corrosion protection measures for all structures.
n- Detail BOQ for civil works of CHP & OHP furnished by CIVIL package vendor/ BHEL.

**c- Consultant shall provide all the design calculations, data sheets & drawings in detail for civil works of their scope of CHP & OHP of the project based on the agreed project requirement / design memorandum, mechanical/structural interface requirement and assist BHEL for getting approval of the same from the customer as required, which shall include (but not limited to) the following:**

1. Detailed design drawings/designs/ review fabrication drawings/ prepare bar bending schedule of the foundation (detailed general arrangement drawings) and super structure within 7 to 15 days from the date of submission of the drawings / input data.
2. All the revised design and drawings in a progressive manner as per our **$L_2$** plan from the date of award of contract.
3. As built drawings progressively after completion of the construction as per our **$L_2$** plan
4. Method of shoring/ strutting sheet piling etc. for deep foundation.
5. The design and drawings of the temporary staging at all critical structures including the live load and dead load considered in the design of temporary work.
6. Method of specialized dewatering in deep foundation like well point system etc.
7. The construction methods which include special forms for staging if any:
8. Treatment at construction joints during unplanned interruption etc.
9. The design calculations and drawings for foundations/substructure and superstructure of all structures/buildings including pump houses and other structures.
10. The design calculations including dynamic analysis and drawings for all foundations subjected to dynamic loads. Design and drawing of vibration isolation system shall also be scrutinized.
11. The design calculations and drawings for all facilities and services like roads, culverts, bridges, pavings, road/rail crossings, drainage pump house (if required), drains, sewers, water tank, sumps, tunnels, trenches, ducts etc.
12. The design calculations and drawings for plumbing and building drainage.

13. All other designs, details/drawings or any other submissions as indicated elsewhere in this specification and as required by the owner/BHEL as part of CHP & OHP package.
14. To prepare as built design and drawings to be submitted on completion of the project.
15. Drawing showing underground facilities with coordinates of these facilities like buried pipes, buried cables, trenches, ducts, sewer drawings, sumps pits, culverts, foundations etc.
16. Checks for stability calculations for wind, earthquake and hydro static forces to be considered along with recommendations on factor of safety.

## D- SCOPE RELATED TO VISITS FOR ENGINEERING CONSULTANCY WORK

**Out station visits for discussions & meetings for execution of the project to BHEL ISG unit at Bangalore/ customer's consultants and any other place as required for carrying out work as specified in points in scope above, shall be included by the party subject to a maximum of 30 man-visits of 3 working days as per the requirement.**

## E- GENERAL

The consultant shall also cover the following:

a. Man hour and Computer hour as per the requirement for completion of activities as detailed in point's related to above scope is included as part of scope.
b. Design of all drawings and documents as mentioned in points B above, which are prepared by the contractor each time for review till final approval both hard & soft copies each time.
c. Design of as-built drawings final distribution (in the scope of the consultant in points A & B above)
d. Overall review of interfacing between existing Civil works.
e. Drawings and documents submitted to customer / consultants for review as mentioned in the scope shall be checked thoroughly by the consultant with respect to contract specifications, parameters, MOC, plant layout, co ordinates, flow diagram etc.
f. The drawings prepared by the consultant shall be duly stamped & signed by consultants with stamp with date of preparation. Required copies of these drawings/documents after stamping shall be sent to BHEL-ISG as per agreed schedule.
g. Flow of submission of various design drawings/documents at various stages of project shall be worked out after placement of P.O.
h. The Consultant shall include any specific technical services not mentioned in the specification but considered essential for completion of the project.

i. Any revision and repetition of the works specified above in points B on account of project requirement, revision shall be done by the consultant without any additional cost to BHEL.
j. The Design-consultant shall also be required to prepare the already approved design / drawings and / or include the substitution in steel sections depending upon material availability and project time schedule requirements. These may have to be resorted to even after completion and approval of construction / fabrication drawings, without any extra cost to BHEL.
k. The estimated Bill of Materials of major Civil items to be prepared as per for Construction drawings for one time.
l. Design-Consultant shall be also responsible for the adequacy of the design and detailing.

**E. Design Considerations for RCC:**

The design documents & drawings shall generally as per following guidelines.

**1.1.0 General**

**1.1.01** Structures shall be designed such that they are economical and safe and meet the functional and service requirement of the technological process for which they are designed. The architectural planning of the building shall be based on technological requirements. Under no circumstances shall normal access to all points in the equipment be blocked or obstructed by diagonal bracing.

**1.1.02** The structures shall be designed confirming to the relevant safety regulations, Indian Factory Acts, Factory Rules of State Government, Fire safety rules, Pollution control board, Electricity Rules and stipulations of Statutory bodies as applicable to the project and as per relevant Indian Codes of Practice or, any International Code approved by the Purchaser.

**1.1.03** All the T.P. / Junction Towers shall house the required coal conveyor as per coal flow diagram. The consultant shall design at all the floor considering the loads from conveyor short post and head end frame work etc. The exact load data and arrangement for coal conveyors, Wagon Tippler, Track hopper, Stacker Reclaimer, Dust extraction system and other plant and equipment of coal handling plant and Ore handling plant shall be furnished by equipment supplier / their consultant to the consultant during detailed engineering and minor variation in the equipment loads is likely and consultant to recheck the design / drawings without any additional / extra commercial implication to BHEL. However during detail engineering stage for preparation of CHP & OHP related structure of Coal Handling and Ore handling package supplier input like, profile of conveyors and inclination, etc will be furnished. Design of foundation for junction houses and gallery trustles to be submitted by the consultant based on approved design memorandum. Bidder shall note that all R.C.C. structure related to track hopper, conveyor galleries, transfer towers, trestles, CH, SRC, etc & PH, Control buildings and all other auxiliary structure and their substructure to be included in the scope of consultancy.

**1.1.04** Consultant to check and ensure that no Loads other than the vertical loads of interconnecting platforms / structures shall be transferred to any nearby structure that is covered under different package.

**1.1.05 D**esign for all the civil buildings covered under the scope shall be done based on detailed specifications **mentioned in** different Sections.

**Annexure-9**
**DETAIL SPECIFICATION FOR SILOS**

Slip Form Construction techniques, as this name suggests, is a sliding-form construction method of pouring vertical concrete structures. It begins with the construction of a fixed diameter form on top of a foundation, with a back-up support and bracing system to ensure that the form maintains its shape during movement.

Inside and outside forms create the cavity of the wall, and inside this cavity, reinforcing steel is tied together vertically and horizontally to reinforce the concrete wall. The form is then connected to jack rods with hydraulic jacks, which automatically move the form vertically in minute increments as the concrete is being poured.

Once pouring begins, it continues until the top of the structure is reached, allowing for a monolithic poured concrete structure.

**QA requirement for Silo Work and slip form shuttering**

Concreting of the foundation shall be carried out in segments as approved by the engineer. Only vertical construction joints with joggles shall be permitted between any two segments. Dowel bars shall also be provided between two adjoining segments. Horizontal construction joints shall not be permitted for the foundation under any circumstances.

Foundation concrete shall be moist / damp cured for at least 10 days by water spraying or ponding as approved by the engineer-in-charge.

Slip form shuttering shall be used for the construction of silo and it shall be checked with respect to the rates of sliding delay in sliding discontinuous (or stop start) sliding, curing, protection, finishing, location of opening, embedment and for vertically.

The rate of movement of the sliding form work shall be such that the concrete at the bottom of the sliding formwork shall have obtained sufficient strength so that it can support itself and all loads that may be imposed on it at that time

It shall be ensured that not more than 25% of the bars are spliced along any plane of the shell.

Vertical joints shall not be permitted in the silo shell horizontal construction joints may be provided at locations as approved by the engineer.

Concrete curing shall be carried out either by moist curing or by membrane curing to be decided by the engineer based on site conditions

The slip form shall have independent controls to counteract any tendency of the structure to travel out of plumb or to slew, twist rock or float. The plumb and alignment shall be checked by means of LASER equipment

An accurate height measure shall be installed in the silo

Bought out items such as paint, acid resistant bricks, acid-resistant cement as per IS 4832 (Part 1 & II), Acid resistant Bitumen mastic, insulation, fabric compensator etc shall conform to the relevant codes

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