MAHAGENCO

MAHARASHTRA STATE POWER GENERATION CO. LTD.

PROJECTS & PLANNING DEPARTMENT

BID SPECIFICATION NO.: DG/BSL U-6/2011/T-1

VOLUME – VI B

TECHNICAL SPECIFICATIONS FOR CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

CONSULTANT

PROCON ENGINEERS

(DIV. OF NIMOTO CONSULTING ENGINEERS PVT. LTD.)

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2011

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VOLUME VI/B

TECHNICAL SPECIFICATIONS

FOR

CIVIL, STRUCTURAL AND ARCHITECTURAL WORKS

CONSULTANT : PROCON ENGINEERS

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VOLUME VI-B

SECTION – 1

AREA GRADING

CONSULTANT : PROCON ENGINEERS

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1.0 SCOPE

This specification shall govern all clearing, grubbing, excavating, area filling, grading and compacting soils for areas designated on the drawings. The work shall include clearing and grubbing, stripping and storage of top soil, excavation, blasting (if required), hauling, dumping and spreading of soil, undercutting to remove unstable soil areas, compacting existing soil surfaces and bottom of excavated areas to receive fills, compacting excavated areas for sub-grade, placing and compacting soils in fills, dealing with surface water, pumping to keep excavated areas and areas to be filled dry, final grading of designated areas, disposing of unsuitable and excess excavated materials and incidentals thereof.

2.0 GENERAL

2.1 WORK TO BE PROVIDED FOR BY THE CONTRACTOR

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following:

2.1.1 Furnish all labour, supervision, services, earth-moving machineries and equipment, compaction plant and equipment, tools and plants, survey instruments, transportation etc. required for the work.

2.1.2 Prepare and submit working drawings showing the approaches, slopes, berms, sumps for dewatering, space for temporary stacking of spoils, disposal area, borrow pits, fencing etc. and all other details as may be required by the Engineer.

2.1.3 To carry out and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

2.1.4 If blasting is resorted to, necessary licenses to be procured from the proper authorities.

2.2 WORK TO BE PROVIDED FOR BY OTHERS

No work under this specification will be provided by any agency other

than the Contractor unless specifically mentioned elsewhere in the Contract.

2.3 CODES AND STANDARDS

All work under this specification, unless specified otherwise, shall conform to the latest revision and/or replacements of the following or any other relevant Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification any other standard practice as may be specified by the Engineer shall be followed:

2.3.1	IS : 1200	:	Method of Measurement of Building and Civil Engineering work, Part-I Earthwork
2.3.2	IS : 2720 (Part-II)	:	Determination of Moisture Content
2.3.3	IS : 2720 (Part-IV)	:	Grain Size Analysis
2.3.4	IS : 2720 (Part-VII)	:	Determination of Moisture Content/Dry
2.3.5	IS : 2720 (Part-VIII)	:	Determination of Moisture Content/Dry
2.3.6	IS : 2720 (Part-XIV)	:	Determination of Density Index (Relative)
2.3.7	IS : 2720 (Part-XXIV)	:	Determination of Dry Density, in place
2.3.8	IS : 2720 (Part-XXVIII)	:	Determination of Dry Density of Soils,
2.3.9	IS : 3764	:	Safety Code for Excavation Work
2.3.10	IS : 4081	:	Blasting and related drilling operations
2.3.11	IRC : SP-11	:	Hand book of quality control for construction of roads and runways
2.3.12	IRC : 36	:	Construction of Earth Embankments for Road Work

2.4 CONFORMITY WITH DESIGNS

The Contractor shall carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or

the Engineer's instructions.

2.5 MATERIALS TO BE USED

2.5.1 General

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.5.2 Borrow Material

Borrow material required for area filling shall be excavated from approved locations and levels, and shall consist of selected material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. Clean graded sand, free from harmful and deleterious materials from approved quarries, shall be used as fill material at places approved during detail engineering stage.
Necessary arrangement shall be done by the Contractor at his own cost for locating and using the borrow areas as the source of supply of filling material.

The depth of borrow pits should be so regulated that the borrow pits do not cut an imaginary line having a slope of 1 vertical in 4 horizontal projected from the edge of final section of the adjacent embankment of stack of excavated soil.

2.6 QUALITY CONTROL

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

(a) Lines, Levels and Grades

(i) Periodic Surveys

(ii) Establishment of markers, Boards etc.

(iii) Checking levels and slopes of the graded surface.

(b) Area filling

(i) Checking the quality of fill material

(ii) Checking moisture content of the fill.

(iii) Checking the degree of compaction.

2.6.1 Any work which fails to conform to the specifications will be subject to the issue of a Non-conformance Report in line with the Quality Control Procedure to be implemented at site. Corrective or remedial action, design modifications or product rejection will be reviewed in accordance with the site Quality Plan.

2.7 INFORMATION REGARDING SITE CONDITIONS

Boring and sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawings or otherwise furnished to the Contractor shall be taken as guidance only and variation there from shall not affect the terms of the Contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and/or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the Contract so that he may evolve a realistic programme of execution.

3.0 EXECUTION

3.1 GENERAL

The work shall be undertaken in accordance with the lines, levels, grades and details shown on the drawings, specification and the approved method of work.
The works shall be carried out in a workman like manner without endangering the safety of nearby structures, roads, railway tracks, cable, pipelines, etc. and without causing hindrance to construction activities.

Suitable approaches, fencing, area lighting and temporary works required for the works shall be provided by the contractor. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where damping from a high bench is in progress, if directed by the Engineer. Adequate area lighting shall be provided by the contractor, if night work is undertaken.

The Contractor shall submit a proposal covering the proposed excavation and placement of fill material for approval of the Engineer. The proposal shall include but not be limited to the following.

(a) Mobilisation and demobilisation of plant

(b) Proposed plant and equipment, labour resources & supervision.

(c) Details of proposed method of clearing and grubbing for each area of cut and fill.

(d) Drawings showing the areas for placement of material.

(e) Management of excavation and filling works i.e. control of setting out, testing procedures, handling, temporary stockpiles etc.

(f) Temporary works proposals

(g) Excavation, filling and compaction by mechanical plant

(h) Dealing with surface water

(i) Dewatering

(j) Disposal of materials

(k) Safety precautions, fencing and lighting

(l) Calculations as appropriate to support work proposal

3.2 SETTING OUT

The Contractor will prepare and submit to the Engineer, detailed drawings of the excavation and filling work necessary, as proposed to be executed by him, showing the dimensions as per drawings and specification, adding his proposals for slopes, approaches, dewatering sumps, berms etc. On receiving the approval from the Engineer with modifications and corrections if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for future checking. These permanent points and markers will be checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instruments for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines, levels and grades as per drawing and subsequent corrections, if any. In case any errors are noticed in the Contractor's work at any stage, the same shall be remedied by the Contractor.

3.3 INITIAL LEVELS

Initial levels either in a definite grid pattern or as directed by the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements. These initial levels and cross-sections shall be jointly signed by the Contractor and the Engineer before commencement of work.

3.4 CLEARING AND GRUBBING ETC.

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. Trees upto 300 mm girth shall be uprooted. Trees above 300 mm girth which are required to be cut, shall be got identified by the Engineer and then marked.

Felling of trees shall include taking out roots upto 600 mm below ground level. After the tree is cut and roots taken out, the pot- holes formed shall be

filled with good earth in 250 mm layers and compacted to acceptable degree unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer and then shall be transported to the Owner's store or any other space as directed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed as directed by the Engineer. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.5 CLASSIFICATION

Materials involved in earthwork shall be classified under the following categories. No distinction will be made whether the material is dry or wet. The Engineer's decision in regard to such classification shall be final and binding on the Contractor:

(a) Ordinary and hard soil

This shall include clay, silt, sand, moorum, shingle, kankar, gravel, loam, peat, ash and other similar materials in soft, hard or dense state which can generally be excavated with ordinary spade, pick axe, shovel etc. and does not require the use of wedges, pneumatic breaking equipment and/or blasting for removal. It shall also include loose rock boulders present in the soil, with dimensions not exceeding 500 mm in any direction.

Breaking of consolidated brick ballast and mud concrete shall be considered equivalent to excavation work under this type of soil.

(b) Soft and Decomposed Rock

This shall include rocks like chalk, slate, mica schist, laterite and other similar materials which in the opinion of the Engineer is rock, but does not require blasting for removal and could be removed with picks, hammers, crow bars, wedges, pneumatic breaking equipment etc. It shall also include boulders with dimensions greater than 500

mm but not exceeding 1000 mm in any direction. The mere fact that the Contractor resorts to blasting for his own convenience shall not mean that the rock will be classified as hard rock.

(c) Hard Rock

This shall include rocks occurring in large masses which cannot be removed except by blasting. Harder varieties of rock such as trap, with or without veins and secondary mineral which in the opinion of the Engineer require blasting for removal shall also be considered as hard rock. It shall also include boulders bigger than 1000 mm in any direction. Construction in concrete, both reinforced and unreinforced, which is required to be dismantled during earthwork.

3.6 EARTHWORK IN EXCAVATION

3.6.1 General

Before commencement of excavation the existing ground surface shall be cleared in accordance with Clause no. 3.4.

All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor, in each individual case, for the method he proposes to adopt for the excavation including dimension, side slopes, dewatering, disposal, etc.

This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level.

3.6.2 Excavation in Ordinary Soil, Hard Soil & Soft and Decomposed Rock

The excavation in ordinary soil, hard soil and soft and decomposed rock shall be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work shall be carried out in a workmanlike manner without endangering the safety of nearby structures or roads, railway tracks, cables, pipelines etc. if any, and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation.

On completion, the work will be finally checked and approved by the Engineer. In case where excavation in soil, soft and decomposed rock and/or hard rock are involved, the soil or soft and decomposed rock layers, shall be removed by turn and levels of the underlying rock surfaces observed to enable measurements. Further work shall be resumed after getting clearance from the Engineer.

3.6.3 Excavation in Hard Rock

Overburden, if any, consisting of top soil, ordinary and hard soil, soft and decomposed rock as per classification of soil, which do not require blasting shall be completely stripped off and the levels of the hard rock surface shall be taken to enable measurement. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any

other approved method. All loose or loosened rock in the sides shall be removed by barring, wedging, etc.

3.6.4 Blasting

3.6.4.1 General

Excavation shall be continued in hard rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines for the excavation, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Engineer, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structure as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Engineer. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

Unless otherwise stated herein, I.S. Specification IS: 4081 "Safety Code for Blasting & Related Drilling Operation" shall be followed.

Specific permission of Engineer will have to be taken by Contractor for blasting rock and he shall also obtain a valid Blasting licence from the authorities concerned.

Contractor shall obtain necessary licence for storage of explosives, fuses and detonators issued to him from owner's stores or from supplier arranged by him, from the authorities dealing with explosives.

The fees, if any, required for obtaining such licence, shall be borne by Contractor. Contractor shall have to make necessary storage facilities for the explosives etc. as per rules of local, State and Central Govt. authorities and statutory bodies/ regulations.

In no case shall blasting be allowed closer than 30 metres to any structure or to locations where concrete has just been placed. In the latter case the concrete must be at least 7 days old.

Contractor shall employ a competent experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.

Before any blasting is carried out, Contractor shall intimate Engineer and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.

The blasting of rock near any existing buildings, equipments or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be done with small charges and where directed by Engineer, a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.

When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an over break limit of 75 mm shall be filled up as instructed by Engineer, with concrete of strength not less than M 10. Stepping in rock excavation shall be done by hand trimming.

Contractor shall be responsible for any accident to workmen, public or Owner's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other authority duly constituted under the State and/or Union Government.

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.
No child under the age of 16 and no person who is in a State of intoxication

shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.6.4.2 Material

All materials such as explosives, detonators, fuses tamping materials etc. proposed to be used in the blasting operations shall have the prior approval of the Engineer.

Only explosives of approved make and strength are to be used. The fuses known as instantaneous fuse must not be used.

The issue of fuse with only one protective coat is prohibited. The fuse shall be sufficiently water resistant as to be unaffected when immersed in water for thirty minutes. The rate of burning of the fuse shall be uniform and not less than 4 seconds or inch of length with 10% tolerance on either side.

Before use, the fuse shall be inspected and moist damaged or broken ones discarded. The rate of burning of fuses or when they have been in stock for long shall be tested before use.
The detonators used shall be capable of giving an effective blasting of the explosives. Moist and damaged detonators shall be discarded.

3.6.4.3 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules. Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The megazine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.
Fuses and detonators shall be stored in separate magazines. However,

detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine.

Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Persons entering the magazine, must put on the magazine shoes which shall be provided at the magazine for this purpose and should be careful:

(a) Not to put their feet on the clean floor unless they have the magazine shoes on.

(b) Not to allow the magazine shoes to touch the ground outside the clean floor.

(c) Not to allow any dirty or grit to fall on the clean floor.

Persons with bare feet, shall before entering the magazine, dip their feet in water and then step direct from the tub over the barrier (if there be one) on to the clean floor.

A brush broom shall be kept in the lobby of the magazine for cleaning out the magazine on each occasion, if it is opened for the receipt, delivery or inspection of explosives.

No matches or inflammable materials shall be allowed inside the magazine. Illumination shall be obtained from an electric storage battery lantern. No smoking shall be allowed within 100 m of a magazine.

No person having article of steel or iron on him shall be allowed to enter the magazine.

Oily cotton, rag waste and articles liable to spontaneous ignition shall not be allowed inside the magazine.

Workmen shall be examined before they enter the magazine to see that they have none of the prohibited articles on their person.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides, special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor any person shall be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record of the results of such inspections shall be kept.

3.6.4.4 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site. Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.6.4.5 Use of Explosives

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith.

The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shotfirer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shotfiring cable in a simple series circuit.

Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any Kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shotholes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shotfirer himself. The shotfiring cable shall not be dragged along the ground to avoid possible damage to the insulation. The shotfiring cable shall be tested for continuity and possible short circuiting before it is used each time.

The shotfirer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encircled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations, the authorised shotfirer shall return to the blast area and inspect carefully and shall compare the number of blasts planted/fired to the actual number of shots heard and satisfy himself that all blast have exploded. Withdrawal unexploded charges shall not be permitted.

The unexploded charges shall be flooded with water and the hole shall be marked in distinguishable manner. Another hole shall be made by drilling a parallel fresh hole not less than 450 mm from misfired hole and fired in the usual way. The process shall be continued till the original blast is exploded. The engineer shall also be informed by the Contractor of all the cases of misfired/unexploded charges, their causes and steps taken. The authorised shotfirer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.6.5 Disposal

The excavated spoils will be disposed off within the specified lead in any or

a combination of some of the following manners, as directed by the Engineer:

(a) By stacking separately the materials suitable for area filling and materials not suitable.

(b) By stacking it temporarily for use in backfilling at a later date.

(i) By either spreading, or

(ii) Spreading and compacting at designated filling areas and/or disposal areas.

3.6.6 Dewatering

All areas shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer, any water inclusive of rain water and subsoil water accumulated in the area. Method of dewatering shall be got approved by the Engineer.

3.6.7 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

Working surfaces shall be formed to such falls to shed water and prevent ponding.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.7 TREATMENT OF SLIPS

The Contractor will take all precautions to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond control of the Contractor, the same shall be removed by him.

3.8 EARTHWORK IN FILLING

3.8.1 Area Filling for Grading

The material to be used for area filling shall be selected material capable of being compacted to the requirements stated herein below and approved by the Engineer, obtained directly from excavation for area grading, from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits in selected areas designated/approved by the Engineer. The quality of the material shall conform to that mentioned in clause 2.5.2 of this specification.

Where excavated material is mostly rock, the boulders shall be broken into pieces not more than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill up the voids and the mixtures used for filling.

If any material is rejected by the Engineer, Contractor shall remove the same forthwith from the site at no extra cost to the Owner. Surplus fill material shall be deposited/disposed of as directed by the Engineer after the fill work is completed.

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

Before commencement of area filling, the existing top soil shall be removed upto a minimum depth of 150 mm or more, as directed by the Engineer in order to clear the surface of undesirable materials. After this, the filling operation shall be performed with earth in layers not exceeding 250 mm,

loose thickness. Successive layers shall not be placed until the layer under construction has been thoroughly compacted to the specified requirements as given below and got approved by the Engineer.

(a) Each layer of earth of cohesive in nature shall be compacted to 95% of proctors dry density unless otherwise permitted/directed by the Engineer.

(b) Each layer of earth of non-cohesive in nature shall be compacted to minimum 75% relative density unless otherwise permitted/directed by the Engineer. Each shall be compacted with approved machine (mechanical plant) and usually manual compaction shall not be allowed unless specifically permitted by the Engineer. The original ground formation and each fill layer shall be compacted by rollers as described below with a maximum of six passes of 8/10 tonne roller.

(i) When the optimum moisture content of soil is relatively high, a pneumatic tyred roller (tyre pressure 3.0 - 3.5 kg/sq.cm) shall be considered to give better performance for mechanical compaction.

(ii) When the optimum moisture content of soil is relatively low, a vibrating roller shall be considered to give better performance for mechanical compaction.

Since the degree of compaction depends on the moisture content of the soil, a close watch shall be kept on this aspect and corrections done to optimise the moisture content. The adequacy of the compaction and moisture content of the soil shall be determined by performing field density tests and other tests as and when directed by the Engineer and shall conform to the stipulations laid down in IS:4701.

The cohesionless soil to be used for area filling, should be placed in fully saturated condition to obtain the maximum possible density. The saturation moisture content shall be determined by laboratory tests prior to commencement of work.

Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed.

When density measurements reveal soft areas in the construction, further compaction shall be undertaken at the contractor's cost as directed by the Engineer. If the required compaction is not achieved, the material in the soft area shall be removed and replaced by approved material and compacted in accordance with this specification, all to the contractor's account.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 tonne roller. No less than 12 passes of the roller shall be accepted before subsequent similar operations are taken up.

3.8.2 Filling in Disposal Areas

Excavated materials if not used in area filling, will be disposed of in designated disposal areas as directed or as indicated in the drawings. The earth shall not be dumped haphazardly but shall be spread in horizontal layers not exceeding 500 mm in thickness and nominal compaction done to the satisfaction of the Engineer.

All clods shall be broken before placing the fill. Earthmoving machinery including dumpers, dozers and trucks shall be allowed to ply over the fill to permit compaction to take place.

In wide areas rollers may be employed and nominal compaction done to the satisfaction of the Engineer.

3.9 COMPACTION CONTROL

The density of each layer of compacted soil shall be ascertained by testing a number of samples. For this purpose the necessary arrangements for soil testing at the site shall be made by the Contractor in accordance with these specifications and as directed by the Engineer.

The Contractor shall arrange the provision of the field laboratory including the testing equipment and a suitable motor vehicle. He shall also supply all consumable materials such as kerosene, spirit, gas and sample bags, as required.

All soil testing is to be carried out by a competent and suitable qualified engineering testing firm. The Contractor is to obtain the Engineer's approval for the firm to be used. The Contractor may undertake this work with the Engineer's approval.

All density testing shall be carried out on a lot by lot basis. A lot shall be considered to be a portion of work which is essentially homogeneous with respect to material type general appearance response during compaction, moisture condition during compaction, compaction process and state of underlying material.

All fill testing shall be carried out in accordance with the recent editions of relevant Indian Standards. The chainage and the off-set from the centre line of the fill of each test sample shall be recorded and presented along with the test results.

Each test lot shall be classified as cohesionless or cohesive. The classification shall be determined by the Engineer based upon particle size distribution. Cohesionless fill shall have 10% or less by mass of particles finer than 0.075 mm. Otherwise fill shall be treated cohesive.

For cohesionless fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum and minimum dry density. These reference values of dry density shall be used to compute the density index (relative density) of each of the field density test samples taken from the test lot.

For cohesive fill material, a representative laboratory sample obtained from three field samples from each test lot shall be tested to determine its maximum dry density and optimum moisture content (OMC). These reference values of dry density and moisture content shall be used to compute the dry density ratio of each of the field density test samples taken from that test lot.

The degree of compaction shall be determined by considering the mean density of the samples in each test lot. The mean dry density shall be equal to or exceed the minimum specified density. In no individual case shall density be less than the minimum value specified by more than 2 percent; otherwise further rolling shall be done at the appropriate locations.

The contractor shall lay a further layer or fill only after compaction or a particular layer has been found and approved by the Engineer.

4.0 TESTING AND ACCEPTANCE CRITERIA

4.1 SOIL TESTING

The following tests shall be undertaken by the Contractor and results and reports shall be submitted to the Engineer for approval. Test failures are to be immediately notified to the Engineer, otherwise results to be submitted within 24 hours of testing. Each layer of material shall be tested for compaction.

Each layer is to be tested in a manner that is representative of its full depth. The Engineer may at his discretion instruct the Contractor to increase or decrease the frequency of testing.

(a) Minimum one test per 500 cu.m. of soil coming out of the borrow pits for determination of natural moisture contents in order to evaluate how far the natural moisture content tallies with the optimum value and whether further addition or reduction of water content would be necessary. Test to be done in accordance with IS: 2720 (Part-II).

(b) Minimum two sets of laboratory tests per 8000 cu.m. of soil coming out of the borrow pits for determination of dry density at optimum

moisture content. Test to be done in accordance with IS: 2720 (Part-VII, XIV, XXVIII, XXIV) as applicable.

(c) Minimum two sets of test per 500 cu.m. of loose fill for determination of moisture content just prior to compaction of area filling. Test to be done in accordance with IS: 2720 (Part-II).

(d) For each compacted layer, minimum one test per 2000 sq.m. of compacted area for determination of moisture content and dry density.

(e) Minimum two tests per 8000 cu.m. of soil for determination of soil classification. Test to be done in accordance with IS: 2720 (Part-IV).

(f) Minimum 10 (ten) density measurements shall be plotted to establish moisture content-dry density relationship.

4.2 ACCEPTANCE CRITERIA

4.2.1 Excavation

On completion of excavation, the dimensions of the area will be checked as per the drawings after the area is completely dewatered. The work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by compacted earth. Over excavation of the sides will be made good free of cost by the Contractor. The excavation work will be accepted after the above requirements are fulfilled & all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.2.2 Area-filling

The degree of compaction required will be as per the stipulations laid down in appropriate sections of this specification. The actual method for measuring the compaction achieved will be as decided by the Engineer. The work of area filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.0 INFORMATION TO BE SUBMITTED

5.1 WITH TENDER

Following details of Machineries, transport vehicles, equipment proposed to be used for excavation, area-filling and compaction have to be submitted along with the tender:

(a) Equipment, machinery & earthmoving vehicles, available with the Contractor and proposed to be used for excavation and haulage giving details regarding make, model, capacity, year of manufacture, numbers available for this contract and general condition.

(b) Equipment proposed to be used for area filling and compaction giving similar details as in item 5.1 (a) above.

(c) Method of transportation.

5.2 AFTER AWARD

After award of contract the successful bidder shall submit the following for approval and adoption:

(a) Within 15 days of Award of the contract, the Contractor shall submit a detailed programme of work as proposed to be executed giving completion dates of excavation of the various areas and the time required for area-filling and compaction. The programme should also show how the excavation and area-filling quantities will be balanced, minimising temporary stacking of spoils.

It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with overall construction schedule without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

(b) Within 15 days of award, the Contractor shall submit drawings showing details of slopes, approaches, sump pits, dewatering lines, borrow pits, if any, fencing etc. for approval of the Engineer for adoption.

VOLUME VI-B

SECTION – 2

EARTHWORK IN EXCAVATION AND BACKFILLING

CONSULTANT : PROCON ENGINEERS

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1.0 SCOPE

This specification covers excavation in all types of soil, soft and decomposed rock not requiring blasting and rocks requiring blasting, shoring, dewatering, filling around foundations and to grade, compaction of fills and approaches, protective fencing, lighting, etc. relevant to structures and locations covered under the scope of this contract.

2.0 GENERAL

2.1 WORK TO BE PROVIDED FOR BY THE CONTRACTOR

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following:

(a) Furnish all labour, supervision, services including facilities as required under statutory labour regulations, materials, scaffolds, equipment, tools and plants, transportation, etc. required for the work.

(b) Prepare and submit working drawings showing the approaches, slopes, berms, shoring, sumps for dewatering, including drains and outfall for drainage, space for temporary stacking of spoils, disposal area, fencing, etc. and all other details as may be required by the Engineer.

(c) To carry out sampling and testing and submit to the Engineer, results of soil compaction tests whenever required by the Engineer to assess the degree of compaction.

(d) Construction, maintenance and removal after completion of magazine of proper capacity as well as design for storing of explosives required for blasting work to be carried out under the scope of this Tender including procurement of necessary licenses from proper authorities.

2.2 WORK TO BE PROVIDED FOR BY OTHERS

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.3 CODES AND STANDARDS

All works under this specification, unless specified otherwise, shall conform to the latest revision and/or replacement of the following or any other Indian Standard Specifications and Codes of Practice. In case any particular aspect of work is not covered specifically by Indian Standard Specification, any other standard practice as may be specified by the Engineer shall be followed.

(a)	IS:1200 (Part-I)	:	Method of Measurement of Building and Civil Engineering work; Part - I Earthwork.
(b)	IS:2720 (Part-II)	:	Determination of Moisture Content
(c)	IS:2720 (Part-VII)	:	Determination of Moisture content / Dry Relation using Light Compaction.
(d)	IS:2720 (Part-XIV)	:	Determination of Density Index (Relative Density) of cohesionless soils.
(e)	IS:2720 (Part xxix)	:	Determination of Dry Density, in place, by core cutter method.
(f)	IS:2720 (Part-xxviii)	:	Determination of Dry Density of soils, in place, by sand replacement methods.
(g)	IS:3764	:	Safety code for Excavation work.
(h)	IS:4081	:	Blasting and Related Drilling Operations
(i)	IS:4701	:	Earthwork on canals

2.4 CONFORMITY WITH DESIGNS

The Contractor is to carry out the work as per the drawings issued to him and/or Contractor's drawings which are approved by the Engineer and/or

the Engineer's instructions.

2.5 MATERIALS TO BE USED

2.5.1 General

All materials required for the work shall be of best commercial variety and approved by the Engineer.

2.5.2 Borrow Material

Borrow material required for back-filling shall be excavated from approved locations and levels, and shall consist of material, approved by the Engineer, free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods. If specified, clean graded sand free from harmful and deleterious material from approved quarries shall be used as fill material.

2.6 QUALITY CONTROL

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. The quality control operation shall include but not be limited to the following items of work:

2.6.1 Lines, Levels and Grades

(a) Periodic Surveys

(b) Establishment of markers, boards etc.

(c) Checking the quality of fill material

2.6.2 Back-filling

(a) Checking moisture content of the back fill

(b) Checking the degree of compaction

2.7 INFORMATION REGARDING SITE CONDITIONS

Surface and Sub-surface data regarding the nature of soil, rock, sub-soil water etc. shown on drawing or otherwise furnished to the Contractor shall be taken as guidance only and variation there from shall not affect the terms of the contract. The Contractor must satisfy himself regarding the character and volume of all work under this contract and expected surface, sub-surface and/or sub-soil water to be encountered. He must also satisfy himself about the general conditions of site and ascertain the existing and future construction likely to come up during the execution of the contract so that he may evolve a realistic programme of execution.

3.0 EXECUTION

3.1 SETTING OUT

The Contractor will prepare and submit to the Engineer, detailed drawings of the excavation work as proposed to be executed by him showing the dimensions as per drawings and specification adding his Proposals of slopes, shorings, approaches, dewatering sumps, berms, etc. On receiving the approval from the Engineer with modifications and corrections, if necessary, the Contractor will set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking.

These permanent points and markers will be fixed at intervals prescribed by the Engineer and checked by the Engineer and certified by him after which the Contractor will proceed with the work. Engineer shall be provided with necessary men, material and instructions for such checking. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawing and subsequent corrections, if necessary, in case any errors are noticed in the Contractor's work at any stage.

3.2 INITIAL LEVELS

Initial levels of the ground either in a definite grid pattern or as directed by

the Engineer will be taken by the Contractor jointly with the Engineer over the original ground prior to starting actual excavation work and after setting out. These initial levels will be used for preparing cross-sections for volume measurement or for cross-checking the depths obtained from tape measurements.

All records of levels, measurements etc. and also any drawing, cross section etc. made there from, shall be jointly signed by the authorised representative of the contractor and the Engineer before the commencement of work and they shall form the basis of all payments in future.

3.3 CLEARING AND GRUBBING ETC.

The area to be excavated or filled shall be cleared out of fences, trees, logs, stumps, bush, vegetation, rubbish, slush, etc. and levelled up. Trees upto 300mm girth shall be uprooted. Trees above 300 mm girth to be cut, shall be approved by the Engineer and then marked. Felling of trees shall include taking out roots upto 600 mm below ground level or 150 mm below formation level whichever is lower. After the tree is cut and roots taken out, the pot-holes formed shall be filled with good earth in 250 mm layers and consolidated unless directed by the Engineer otherwise. The trees shall be cut in suitable pieces as instructed by the Engineer.

Before earthwork is started, all the spoils and unserviceable materials and rubbish shall be burnt or removed from the site to approved disposal areas as may be specified. Ash shall be spread or removed. Useful materials, saleable timber, firewood, etc. shall be the property of the Owner and shall be stacked properly at the worksite in a manner as directed by the Engineer.

3.4 CLASSIFICATION

All earthwork shall be classified under the following categories : No distinction will be made whether the material is dry or wet.

(a) Ordinary Soil

This shall comprise vegetable or organic soil, turf, sand, silt, loam, clay, mud, peat, black cotton soil, soft shale or loose moorum, a mixture of these and similar material which yields to the ordinary

application of pick and shovel, rake or other ordinary digging implement. Removal of gravel or any other nodular material having diameter in any one direction not exceeding 75 mm occurring in such strata shall be deemed to be covered under this category.

(b) Hard Soil

This shall include:

(i) Stiff heavy clay, hard shale, or compact moorum requiring grafting tool or pick or both and shovel, closely applied.

(ii) gravel and cobble stone having maximum diameter in any one direction between 75 and 300 mm, soling of roads, paths, etc. and hard core,

(iii) macadam surfaces such as water bound and bitumen/tar bound,

(iv) lime concrete, stone masonry in lime mortar and brick work in lime/ cement mortar, below ground level,

(v) soft conglomerate, where the stones may be detached from the matrix with picks and

(vi) generally any material which requires the close application of picks, or scarifiers to loosen and not affording resistance to digging greater than the hardest of any soil mentioned in (i) and (vi) above.

(c) Soft and Decomposed Rock

This shall include:

(i) limestone, sandstone, laterite, hard conglomerate or other soft or disintegrated rock which may be quarried or split with crowbars;

(ii) Unreinforced cement concrete which may be broken up with

crowbars or picks and stone masonry in cement mortar below ground level ;

(iii) Boulders which do not require blasting having maximum diameter in any direction of more than 300 mm, found lying loose on the surface or embedded in river bed, soil, talus, slope wash and terrace material of dissimilar origin ; and

(iv) Any rock which in dry state may be hard, requiring blasting, but which when wet becomes soft and manageable by means other than blasting.

(d) Hard Rock (requiring blasting)

This shall include:

(i) Any rock or cement concrete for the excavation of which the use of mechanical plant or blasting is required ;

(ii) Reinforced cement concrete (reinforcement cut through but not separated from the concrete) below ground level; and

(iii) Boulders requiring blasting.

(e) Hard Rock (blasting prohibited)

Hard rock requiring blasting as described under (d) but where blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging or any other agreed method.

In case of any dispute regarding classification, the decision of the Engineer shall be final.

3.5 EXCAVATION FOR FOUNDATIONS AND TRENCHES

3.5.1 General

All excavations shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained

by the Contractor, in each individual case, for the method he proposes to adopt for the excavations including dimension, side slopes, shoring, dewatering, disposal, etc. This approval, however, shall not in any way make the Engineer responsible for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner.

All excavation in open cuts shall be made true to line, slopes and grades shown on the drawing or directed by the Engineer. No material shall project within the dimension of minimum excavation lines marked. Boulders projecting out of the excavated surfaces shall be removed, if in the opinion of the Engineer they are likely to be a hindrance to the workers.

Method of excavation shall be in every case subject to the approval of the Engineer and the Contractor shall ensure the stability and safety of the excavation, adjacent structures, services and works.

The Contractor shall have full responsibility of the stability of the excavation and safety of the workmen. If any slip occurs, the Contractor shall remove all slipped material from the excavated pit.

All loose boulders, semi-detached rocks, not directly in excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment of the work etc., shall be stripped off and removed away from the areas of excavation. The method used shall be such as not to shatter or render unstable or unsafe the portion which was originally sound and safe. Any materials not requiring removal as contemplated in the work, but which, in the opinion of the Engineer, is later to become loose or unstable shall also be promptly and satisfactorily removed as directed by the Engineer.

Prior to starting the excavation, the ground level at the location shall be checked jointly with the Engineer.

The rough excavation may be carried upto a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If directed by the Engineer, soft and undesirable spots shall be removed even below the final level. The extra excavation shall be filled up as instructed by the Engineer.

If the excavation is done to a depth greater than that shown on the drawing, or directed by the Engineer, due to the Contractor's fault, the excess depth shall be filled up to the required level (with cement concrete not leaner than 1:4:8 ordinary concrete or richer) as directed by the Engineer in each individual case.

In formation of rock requiring blasting, those overcuts which are unavoidable will be made up by ordinary cement concrete 1:2:4. All excavated materials such as hard rock, boulders, bricks, dismantled concrete blocks etc. shall be stacked separately as directed by the Engineer and shall be the property of the Owner.

3.5.2 Excavation in Ordinary Soil, Hard Soil and Soft and Decomposed Rock

The excavation in ordinary soil, hard soil, soft and decomposed rock will be carried out as per the approved proposal, modified and corrected where necessary by the Engineer. The work will be carried out in a workmanlike manner without endangering the safety of nearby structures/services or works and without causing hindrance to other activities in the area. As the excavation reaches the required dimensions, lines, levels and grades, the work will be checked by the Engineer thoroughly and the balance work will be carried out carefully to avoid any over-excavation. On completion, the work will be finally checked and approved by the Engineer. In certain cases, where deterioration of the ground, upheaval, slips etc. are expected, the Engineer may order to suspend the work at any stage and instruct the Contractor to carry out the balance work just before the foundation work of the structure can be started.

3.5.3 Excavation in Hard Rock

In case where excavation, both in ordinary soil and hard rock, are involved, the ordinary soil comprising of soft, hard and dense soils (including laterite formations) and rock including weathered rocks, lateritic rocks, etc. which can be excavated without blasting, shall be completely stripped off. Further work in hard rock shall be resumed after clearance from the Engineer.

Personnel deployed for rock excavations shall be protected from all hazards such as loose rock/boulder rolling down and from general slips of excavated surfaces. Where the excavated surface is such that it is not stable

against sliding, necessary supports, props, bracings or bulkheads shall be provided and maintained during the period of construction. Where danger exists of loose rock/boulder falling from the excavated surfaces deeper than 2 metres, steel mesh anchored to the lower edge of excavation and extending over and above the rock face, adequate to retain the dislodged material shall be provided and maintained.

In case where blasting, though otherwise required, is prohibited for any reasons, the excavation shall be carried out by chiselling, wedging or any other approved method.

3.5.4 Blasting

3.5.4.1 General

Storage, handling and use of explosives shall be governed by the current explosive rules laid down by the Central and the State Governments. The Contractor shall ensure that these rules are strictly adhered to. The following instruction, wherever found in variance with the above rules, shall be considered as superseded by the above rules.

No child under the age of 16 and no person who is in a state of intoxication shall be allowed to enter the premises where explosives are stored nor they shall be allowed to handle the explosives.

3.5.4.2 Storage of Explosive

Storage of explosives shall be governed by the current Explosive Rules, Explosives shall be stored in a clean, dry, well ventilated magazine to be specially built for the purpose. Under no circumstances should a magazine be erected within 400 m of the actual work site or any source of fire. A space surrounding the magazine shall be fenced in. The ground inside the fence shall be kept clear and free from trees, bushes etc. The admission to this fenced space shall be by one gate only and no person shall be allowed inside this fence without permission of the Officer-in-charge. The clear space between the fence and the magazine shall not be less than 90m. The mezzanine shall be perfectly well drained.

Two lightning conductors shall be provided to the magazine, one at each end. The lightning conductors shall be tested once in every year.
Fuses and detonators shall be stored in separate magazines. However, detonators can be kept in an annexe adjoining the magazine provided that their number does not exceed 25,000 and that the annexe is so constructed that not less than 60 cm masonry and 100 cm of air space shall intervene between any detonators in such annexe and the interior of the main magazine. Cases containing explosives are not to be opened in a magazine. Explosive in open cases are not to be received into a magazine. Explosives which appear to be in a damaged or dangerous condition are not to be kept in any magazine, but must be removed without delay to a safe distance and destroyed.

Artificial light is not to be allowed in any magazine. No smoking shall be allowed within 100 m of a magazine.

Magazine shoes without nails shall be used while entering the magazine.

The mallets, levers, wedges etc. for opening barrels or cases are to be of wood. Inside a magazine the cases of explosives are to be carried by hand and shall not be rolled or dragged. Explosives which have been issued and returned to the magazine are to be issued first; otherwise those which have been longest in store are to be issued first.

Cases of explosives must be kept clear of the walls and floors for free circulation of air on all sides. Special care is to be taken to keep the floor free from grains of powder or portions of explosive matter fallen on the floors due to leakage of cases etc.

The magazine shall not be opened during any dust storm or thunderstorm nor shall any person be allowed in the vicinity of the magazine.

All magazines shall be officially inspected at definite intervals and a record kept of the results of such inspections.

3.5.4.3 Carriage of Explosives

Detonators and explosives shall be transported separately to the blast site.

Explosives shall be kept dry and away from the direct rays of the sun, naked lights, steam pipes or heated metal and other sources of heat. Before explosives are removed, each cage or package is to be carefully examined to ascertain that it is properly closed and shows no sign of leakage.

No person except the driver shall be allowed to travel on a vehicle conveying explosives. No carriage or vessel shall be used for transporting explosives unless all iron or steel therein with which a package containing any explosive is likely to come in contact is effectually covered with lead, leather, wood, cloth or other suitable material. No lights shall be carried on the vehicle carrying explosives.

No operation connected with the loading, unloading and handling of explosives shall be conducted after sunset.

3.5.4.4 Use of Explosives

The Contractor shall appoint an agent who shall personally superintend the firing and all operations connected therewith. The contractor shall satisfy himself that the person so appointed is fully acquainted with the responsibilities imposed on him.

Holes for charging explosives shall be drilled with Pneumatic drills, the drilling pattern being so planned that the rock pieces after blasting will be suitable for handling.

The hole diameter shall be of such a size that cartridges can easily pass down them and undue force is not required during charging. Charging operations shall be carried out by or under the personal supervision of the shot firer. Wrappings shall never be removed from explosive cartridges. Only wooden rods shall be used for loading and stemming shotholes. Only one cartridge at a time shall be inserted and gently passed home with the wooden tamping rod.

Only such quantities of explosives as are required for the particular amount of work to be done shall be brought to the works. Should any surplus remain when all the holes have been charged, it shall be carefully removed to a point at least 300 m from the firing point.

The explosives shall be fired by means of an electric detonator placed inside the cartridge. For simultaneous firing of a number of charges the electric detonators shall be connected with the exploder through the shotfiring cable in a simple series circuit. Due precautions shall be taken to keep the firing circuit insulated from the ground, bare wires, rails, pipes or any other path of stray current and to keep the lead wires short circuited until ready to fire. Any kinks in detonator leading wire shall be avoided.

For simultaneous firing of a large number of shotholes, use of cordtex may be done. Cordtex shall be initiated by an electric detonator attached to its side with adhesive tape, connecting wire or string.

All connections shall be made by the authorised shotfirer himself. The shotfiring cable shall not be dragged along the ground to avoid possible damage to the insulation. The shotfiring cable shall be tested for continuity and possible short circuiting before it is used each time.

The shotfirer shall always carry the exploder handle on his person until he is ready to fire shots. The number of shots fired at a time shall not exceed the permissible limits.

Blasting shall only be carried out at certain specified times to be agreed jointly by the contractor and the Engineer.

Before any blasting is carried out, it shall be ensured that all workmen, vehicles and equipment on the site are cleared from an area of minimum 300 metres radius from the firing point, or as required by statutory regulations, at least ten minutes before the time of firing by sounding a warning siren. The area shall be encirled by red flags.

At least five minutes after the blast has been fired in case of electric firing or as stipulated in the regulations the authorised shotfirer shall return to the blast area and inspect carefully the work and satisfy himself that all charged holes have exploded. Cases of misfired unexploded charges shall be exploded by drilling a parallel fresh hole not less than 600 mm from the misfired hole and by exploding a new charge. The authorised shotfirer shall be present during removal of the debris liable to contain unexploded explosives near the misfired hole. The workmen shall not return to the site of firing until at least half an hour after firing.

When blasting is conducted in the neighbourhood of roads, structures, buildings etc. controlled blasting has to be carried out by drilling shallow shotholes and filling the same with light charge of explosives.

Adequate safety precautions as per building bye-laws, safety code, statutory regulations etc. shall be taken during blasting operations.

3.5.5 Disposal

The excavated spoils will be disposed of in any or all the following manners:

(a) By using it for backfilling straightway.

(b) By stacking it temporarily for use in backfilling at a later date during execution of the Contract.

(c) (i) By either spreading, Or

(ii) Spreading and compacting at designated filling areas and /or disposal areas.

(d) By selecting the useful material and stacking it neatly in areas designated by the Engineer for use in backfilling by some other agency.

3.5.6 Disposal of Surplus

All surplus material from excavation shall be carried away from the excavation site to designated disposal area selected by the Engineer.

All good and sound rock excavated from the pits and all assorted materials of dismantled structures shall be the property of the Owner.

3.5.7 Protection

The Engineer shall be notified by the Contractor as soon as the excavation is expected to be completed within a day so that it may be inspected by him at the earliest. Immediately after approval of the Engineer, the excavation must

be covered up in the shortest possible time. But, in no case the excavation shall be covered up or worked on before approval and measurement by the Engineer. Excavated material shall be placed beyond 1.5 metres from the edge of the pit or trench or half the depth of the pit or trench whichever is more or further away if directed by the Engineer.

Excavation shall not be carried out below the foundation level of structure close by until required precautions have been taken.

Adequate fencing is to be made enclosing the excavation.

The Contractor shall protect all under-ground services exposed by excavation. The Contractor shall also divert all surface drains, etc. affected by the excavation to maintain the working area neat and clean.

3.5.8 Dealing with Surface Water

All working areas shall be kept free of surface water as far as reasonably practicable. Works in the vicinity of cut areas shall be controlled to prevent the ingress of surface water.

No works shall commence until surface water streams have been properly intercepted, redirected or otherwise dealt with.

Where works are undertaken in the monsoon period, the Contractor may need to construct temporary drainage systems to drain surface water from working areas.

3.5.9 Dewatering

All excavations shall be kept free of water and slush. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep the trench dewatered until the construction of foundation structure and backfilling are complete in all respects. (Except where such dewatering would need installation of well points or deep wells for which separate payment will be made) Sumps made for dewatering must be kept clear of the foundations. Method of pumping

shall be approved by the Engineer but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping.

3.5.10 Timber Shoring

Timber Shoring made out of approved quality of timber shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench and the type of timbering shall be determined by the Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

3.5.10.1 Close Timbering

Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 250 x 40 mm sections as directed by the Engineer. The boards shall generally be placed in position vertically in pairs, one board on each side of cutting, and shall be kept apart by horizontal walers of strong wood at maximum 1.2 metres spacing, cross strutted with ballies or as directed by the Engineer. The length of the bally struts shall depend on the width of the trench or pit.

In case where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical walers, which shall be strutted to similar timber pieces on the opposite face of the trench or pit. The lowest board supporting the sides shall be taken into the ground. No portion of the vertical side of the trench or pit shall remain exposed, so that the earth is not liable to slip out.

The withdrawal of the timber shall be done very carefully to prevent the collapse of the pit or trench. It shall be started at one end and preceded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried.

3.5.10.2 Open Timbering

In the case of open timbering, the entire surface of the side of trench pit is

not required to be covered. The vertical board of minimum 250 mm width and minimum 40 mm depth shall be spaced sufficiently apart to leave unsupported strips of maximum 500 mm average width. The detailed arrangement, sizes of the timber and the distances apart shall be subject to the approval of the Engineer. In all other respects, specification for close timbering shall apply to open timbering.

3.6 TREATMENT OF SLIPS

The Contractor will take all precaution to avoid high surcharges and provide proper surface drainage to prevent flow of water over the sides. These precautions along with proper slopes, berms, shoring and control of ground water should cause no slips to occur. If however slips do occur due to causes beyond the control of the Contractor, the same shall be removed by him and payment shall be made to him on appropriate item rate of earthwork. Slips caused due to negligence of the Contractor will be cleared and back- filled later by him.

3.7 BACK-FILLING

3.7.1 General

The material used for backfilling shall consist of material, approved by the Engineer obtained directly from nearby areas where excavation work by the same agency is in progress, from temporary stacks of excavated spoils or from borrow pits from selected areas designated by the Engineer. The material shall be free from lumps and clods, roots and vegetations, harmful salts and chemicals, organic materials, etc.

In certain locations, the Engineer may direct sand fillings. The sand should be clean, well graded and be of quality normally acceptable for use in concrete.

3.7.2 Filling and Compaction in Pits and Trenches around Structures

As soon as the work in foundations has been accepted and measured, the spaces around the foundation structures in pits and trenches shall be cleared of all debris, brick bats, mortar droppings, etc., and filled with earth in layers not exceeding 250 mm in loose thickness each layer being watered,

rammed and properly compacted to achieve a dry density of not less that 95% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) where backfilling with cohesive soil and sandy silt containing high percentage of silt. For back filling with sand having little or no silt, each layer shall be compacted to a relative density of 75% as per IS 2720 part XIV. Earth shall be rammed with approved mechanised compaction machine. Usually, no manual compaction shall be allowed unless specifically permitted by the Engineer. The final surface shall be trimmed and levelled to proper profile as shown in the drawing and as desired by the Engineer.

Since the degree of compaction depends on the moisture content of the soil, a close watch should be kept on it and corrections done to optimise the moisture content.

3.7.3 Plinth Filling

The plinth shall be filled with earth in layers not exceeding 250 mm in loose thickness, watered and compacted as stated under clause no. 3.7.2 with approved compaction machine or manually, if specifically permitted by the Engineer. When the filling reaches the finished level, the surface shall be flooded with water for at least 24 hours, allowed to dry and then rammed and compacted, in order to avoid any settlement at a later stage. The finished level of the filling shall be trimmed to the slope intended to be given to the floor.

3.7.4 Filling in Trenches for Water Pipes and Drains

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not bigger than 150 mm size in any direction, mixed with fine material consisting of disintegrated rock, moorum or earth as available, so as to fill up the voids as far as possible and then the mixture used for filling. The types of bedding & pipe surround material shall be as specified in the drawings.

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed.

Where the trenches are excavated in soil, the filling shall be done with earth on the sides and top of pipes in layers not exceeding 150 mm, watered, rammed and compacted taking care that no damage is caused to the pipe below. Filling of trenches shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

In case of excavation of trenches in rock, the filling upto a depth of 300 mm or the diameter of the pipe whichever is more, above the crown of pipe or barrel shall be done with fine material such as earth, moorum, disintegrated rock or ash according to the availability at site. The remaining filling shall be done with rock filling of boulders of size not exceeding 150 mm mixed with fine material as available to fill up the voids, watered, rammed and compacted.

3.7.5 Filling in Disposal Area

Surplus material from excavation which is not required for backfilling will be disposed of in designated disposal areas. The spoils shall not be dumped haphazardly but should be spread in layers approximately 250 mm thick when loose and compacted with the help of compacting equipment. In wide areas rollers will be employed and compaction done to the satisfaction of the Engineer at the optimum moisture content which shall be checked and controlled by the Contractor.

In certain cases the Engineer may direct disposal without compaction which can be done by tipping the spoils from a high bench neatly maintaining always a proper level and grade of the bench.

3.8 APPROACHES AND FENCING

The Contractor should provide and maintain proper approaches for workmen and for inspection. The roads and approaches around the excavated pits should be kept clear at all times so that there is no hindrance to the movement of men, material and equipment of various agencies connected with the Project. Sturdy and elegant fencing is to be provided around the top edge of the excavation as well as the bottom of the fill at the surplus disposal area where dumping from a high bench is in progress.

3.9 LIGHTING

Full scale area lighting is to be provided if night work is permitted or directed by the Engineer. If no night work is in progress, red warning lights should be provided at the corners of the excavated pit and the edges of the fill.

4.0 TESTING AND ACCEPTANCE CRITERIA

4.1 EXCAVATION

On completion of excavation, the dimensions of the pits will be checked as per the drawings after the pits are completely dewatered the work will be accepted after all undercuts have been set right and all over excavations filled back to required lines, levels and grades by placing ordinary concrete of 1:4:8 proportion and/or richer and/or by compacted earth, as directed by the Engineer. The choice of grade of concrete will be a matter of unfettered discretion of the Engineer. Over excavation of the sides will be made good by the Contractor while carrying out the back-filling. The excavation work will be accepted after the above requirements are fulfilled and all temporary approaches encroaching inside the required dimension of the excavation have been removed.

4.2 BACK-FILLING

The degree of compaction shall be sufficient to achieve a dry density of not less than 95% of proctor's dry density at optimum moisture content as per IS-2720 (Part-VII) or a relative density of 75% as per IS-2720 (Part-XIV) as applicable depending on the nature of back filling material as stated in clause no. 3.7.2 of this specification. The work of back-filling will be accepted after the Engineer is satisfied with the degree of compaction achieved.

5.0 INFORMATION TO BE SUBMITTED

5.1 WITH TENDER

Details of Equipment proposed to be used for excavation, back-filling and compaction have to be submitted along with the tender.

5.2 AFTER AWARD

After award of the Contract the successful tenderer shall submit the following for approval and adoption:

(a) The Contractor shall submit a detailed programme of the work as proposed to be executed giving completion dates of excavation of the various foundations and the time required for back-filling and compaction after completing the foundation for structures.

The programme should show how the excavation and back-filling quantities will be balanced, minimising temporary stacking of spoils. It is to be noted that the Engineer even after initial approval of the programme, may instruct to enhance or retard the progress of work during the actual execution, in order to match with the progress of foundations without attracting any claims from the Contractor. The initial programme being submitted by the Contractor should have sufficient flexibility to take care of such reasonable variations.

(b) The Contractor shall submit drawings showing details of slopes, shorings, approaches, sump pits, dewatering lines, fencing etc. for approval of the Engineer for adoption.

VOLUME VI-B

SECTION – 3

CEMENT CONCRETE (PLAIN & REINFORCED)

CONTENTS

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1.0 SCOPE

1.1 GENERAL

This specification covers all the requirements, described hereinafter for general use of Plain and Reinforced Cement Concrete work in Structures and locations, cast-in-situ or precast, and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

1.2 This specification shall also apply to the extent it has been referred to or applicable with the special requirements of structures covered in SCOPE of IS:456.

1.3 IS:456 shall form a part of this specification and shall be complied with unless permitted otherwise. For any particular aspect not covered by this Code, appropriate IS Code, specificationsand/or replacement by any International Code of practice as may be specified by the Engineer shall be followed. All codes and Standards shall conform to its latest revisions. A list of IS codes and Standards is enclosed hereinafter for reference.

2.0 GENERAL

2.1 WORK TO BE PROVIDED FOR BY THE CONTRACTOR

The work to be provided for by the Contractor, unless otherwise specified shall include but not be limited to the following:-

(a) Furnish all labour, supervision, services including facilities as may be required under statutory labour regulations, materials, forms, templates, supports, scaffolds, approaches, aids, construction equipment, tools and plants, transportations, etc. required for the work

(b) Contractor shall prepare progressively and submit for approval detailed drawings and Bar Bending Schedules for reinforcement bars showing the positions and details of spacers, supports, chairs, hangers etc

(c) Design and prepare working drawings of formworks, scaffolds, supports, etc. and submit for approval

(d) Submit for approval shop drawings for various inserts, anchors, anchor bolts, pipe sleeves, embedment, hangers, openings, frames etc.

(e) Submit for approval detailed drawings of supports, templates, hangers, etc. required for installation of various embedments like inserts, anchor bolts, pipe sleeves, frames, joint seals, frames, openings etc.

(f) Submit for approval detailed schemes of all operations required for executing the work, e.g. Material handling, Concrete mixing, Placement of concrete, Compaction, curing, services, Approaches, etc.

(g) Design and submit for approval concrete mix designs required to be adopted on the job.

(h) Furnish samples and submit for approval results of tests of various properties of the following:

(i) The various ingredients of concrete.

(ii) Concrete.

(iii) Embedments

(iv) Joint seals

(i) Provide all incidental items not shown or specified in particular but reasonably implied or necessary for successful completion of the work in accordance with the drawings and specifications.

(j) For supply of certain materials normally manufactured by specialist firms, the Contractor may have to produce, if directed by the Engineer, a guarantee in approved proforma for satisfactory performance for reasonable period as may be specified, binding both

the manufacturers and the Contractor, jointly and severally.

2.2 WORK BY OTHERS

No work under this specification will be provided by any agency other than the Contractor unless specifically mentioned elsewhere in the contract.

2.3 INFORMATION TO BE SUBMITTED BY THE TENDERER

2.3.1 With Tender

The following technical information are required with the tender:

(a) Source and arrangement of processing of aggregates proposed to be adopted.

(b) Type of plant and equipment proposed to be used.

(c) Names of firms, if any, with which association is sought for to, execute the special items of work in the contract.

(d) Types of formwork proposed to be used.

2.3.2 After Award

The following information and data including samples where necessary shall be submitted by the Contractor progressively during the execution of the contract.

(a) Programme of Execution and Requirement of Materials

The Contractor will submit a Master Programme for completion of the work giving monthwise requirements of materials for the procurement.

This Master Programme may have to be reviewed and updated by the Contractor, quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Contractor before the end of the previous month

(b) Samples

Samples of the following materials and any other materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities for approval. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying materials of specified qualities:

(i) Coarse and fine aggregates

(ii) Admixtures.

(iii) Plywood for Formwork

(iv) Embedded and anchorage materials as may be desired by the Engineer

(v) Joint sealing strips and other waterproofing materials

(vi) Joint filling compounds

(vii) Foundation quality Rubber Pads

(c) Design Mix

Design mix as per Clauses 2.1 (g) & 3.4 of this specification giving proportions of the ingredients, sources of aggregates and cement, along with accompanying test results of trial mixes as per relevant I.S., is to be submitted to the Engineer for his approval before it can be used on the works.

(d) Detail Drawings and Bar Bending Schedules

Detailed working drawings and Bar Bending Schedules in accordance with Clause 2.1(b) and 3.16.1 of this specification.

(e) Detailed Drawings and Designs of Formworks to be used

Detailed design data and drawings of standard formworks to be used as per clause 2.1 (c).

(f) Detailed Drawings for Templates & Temporary Supports for Embedments.

As per Clause 2.1 (e).

(g) Mill Test Reports for Cement & Reinforcing Steel.

(h) Inspection Reports

Inspection Reports in respect of Formwork and Reinforcement and any other item of work as may be desired by the Engineer in accordance with Clause 2.4 of this specification.

(i) Test Reports

Reports of tests of various materials and concrete as required under Clause 4.0: SAMPLING & TESTING of this specification.

(j) Any other data which may be required as per this specification.

2.4 CONFORMITY WITH DESIGN

The Contractor will prepare check lists in approved proforma which will be called 'Pour Cards'. These Pour Cards will list out all items of work involved. The Contractor will inform the Engineer, sufficiently in advance, whenever any particular pour is ready for concreting. He shall accord all necessary help and assistance to the Engineer for all checking required in the pour. On satisfying himself that all details are in accordance to the drawings and specifications, the Engineer will give written permission on the same 'Pour Card' allowing the Contractor to commence placement of concrete. Details of all instructions issued by the Engineer and the records of compliance by the Contractor, deviations allowed by the Engineer and any other relevant information will be written on accompanying sheets attached to the Pour Cards. These sheets, termed as 'Progress Cards', will be

prepared by the Contractor on approved proforma. The Pour Cards along with accompaniments will be handed over to the Engineer before starting placement of concrete. One of the mix designs developed by the Contractor as per the I.S. Specifications and established to the satisfaction of the Engineer by trial mixes shall be permitted to be used by the Engineer, the choice being dictated by the requirements of designs and workability. The methods of mixing, conveyance, placement, vibration, finishing, curing, protection and testing of concrete will be as approved or directed by the engineer.

2.5 MATERIALS TO BE USED

2.5.1 General Requirement

All materials whether to be incorporated in the work or used temporarily for the construction shall conform to the relevant IS Specifications unless stated otherwise and be of best approved quality.

2.5.2 Cement

Generally cement shall be 33 grades ordinary Portland cement conforming to IS 269 .In special cases any of the following type of cement may be permitted or directed to be used with prior approval by the Engineer

(a) 43 Grade ordinary Portland Cement conforming to IS-8112

(b) 53 Grade ordinary Portland Cement conforming to IS-12269

(c) Rapid hardening Portland Cement conforming to IS-8041

(d) Portland slag cement conforming to IS-455

(e) Portland Pozzolona Cement (flyash based) Conforming to IS-1489 (Part-1)

(f) Portland pozzolona Cement (calcined clay based) conforming to IS-1489 (Part-2)

(g) Hydrophobic Cement conforming to IS-8043

(h) Low heat Portland Cement conforming to IS : 12600

(i) Sulphate Resisting Portland Cement conforming to IS-12330

2.5.3 Aggregates

Aggregates shall be natural or crushed gravel or crushed rock and free from deleterious material. It shall comply with the requirements of IS-383. All fine and coarse aggregate shall be tested for susceptibility to Alkali Silicate reaction in a laboratory approved by the Engineer.

(a) Coarse Aggregate

Aggregate of sizes ranging between 4.75 mm and 150 mm will be termed as Coarse Aggregate. Only Coarse Aggregate from approved quarries and conforming to IS:383 will be allowed to be used on the works. Aggregates shall be washed to make it free from deleterious materials, if necessary

The grading of coarse aggregates by seive analysis shall be as per IS:383. If by the analysis the deficiency of a particular grain size is found, which could affect the density of the concrete, the Engineer may ask the contractor to avoid such quantities of aggregate of the particular size or and such quantity of aggregate of any particular size to achieve the required grading as per IS:383.

(b) Fine Aggregate

Aggregate smaller than 4.75 mm and within the grading limits and other requirements set in IS:383 is termed as Fine Aggregate or Sand. Only Fine Aggregate from approved sources and conforming to the above IS Specification will be allowed to be used on works.

In certain cases there may be two types of sand, one very fine and the other very coarse. In such cases, the two types shall be combined to meet the requirements of a particular zone of IS:383. In all cases, the preferred zone is Zone - II.
In certain cases crushed stone sand may be added to natural sand in order to achieve the required grading. Crushed stone sand alone may

be used only with the approval of the Engineer.

2.5.4 Water

Water for use in Concrete shall be clear and free from injurious oils, acids, alkalis, organic matter, salt, silts or other impurities. Normally potable water is found to be suitable. Generally, IS:3550 will be followed for routine tests. Acceptance test for water shall be as per IS:3025, and Table-1 of IS:456.

In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by compressive strength and initial setting time tests as per method of tests in accordance with the requirements of IS-516 & IS- 4031 respectively. The PH value of water shall generally be not less than 6

2.5.5 Admixture

Only admixture of approved quality will be used when directed or permitted by the Engineer. The different types of admixtures which may be necessary to satisfy the concrete mix and the design requirement shall be as per the following I.S. Standards:

IS : 2645 : Integral cement water proofing compound

IS : 9103 : Indian standard specification for Admixtures Concrete or equivalent American Codes (ASTM C494 and ASTM C260) or British Codes (BS 5075, part 1 to 3)and may be one of the following:

(a) Accelerating admixtures:

(i) Set accelerating admixtures like "Sigunit Powder" or "Sigunit LN10"

(b) Retarding admixtures:

(i) Modified ligno sulphonate based set retarding concrete admixture like, "Plastiment R".

(c) Water reducing admixtures:

(i) Modified sulphonated melamine formaldehyde based water reducing concrete admixture like, "Sikament".

(d) Air entraining admixtures:

(i) Modified ligno sulphonate based air entraining concrete admixture like "FLOMO AEP "or surface - active agents like "Sika AER".

(e) Water proofing admixtures

(i) Modified lingo–sulphonate based waterproofing admixture like "Plastocrete Super".

However, the Contractor shall furnish following technical information about the admixtures (along with the manufacturer's Catalogue) which he is planning to use in different areas within the scope of work for the approval of the Engineer.

(i) Type of admixture

(ii) Mix proportion & mode of application in concrete/mortar

(iii) Manufacturer's specification & necessary quality assurance certificates (mainly on chloride & sulphate content, PH value infra red analysis & solid content)

2.5.6 Reinforcement

Reinforcement shall be as per relevant IS Specification as mentioned in the Contract /Drawing/Instructions. All bars shall be of tested quality.

2.6 STORAGE OF MATERIALS

2.6.1 General

All materials shall be so stored as to prevent deterioration or intrusion of

foreign matter and to ensure the preservation of their quality and fitness for the work. Any material, which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used for concrete and shall be removed from site immediately, failing which, the Engineer shall be at liberty to get the materials removed and Storage of materials shall conform to IS:4082.

2.6.2 Cement

Sufficient space for storage, with open passages between stacks, shall be arranged by the Contractor to the satisfaction of the Engineer.

Cement shall be stored off the ground in dry, leak proof, well-ventilated ware-houses at the works in such a manner as to prevent deterioration due to moisture or intrusion of foreign matter.

Cement shall be stored in easily countable stacks with consignment identification marks. Consignments shall be used in the order of their receipts at site. Sub-standard or partly set cement shall not be used and shall be removed from the site, with the knowledge of the Engineer, as soon as it is detected.

Different types of cement shall be clearly marked with the Type and different types of cement shall not be intermixed.

2.6.3 Aggregates

Aggregates shall be stored on planks or steel plates or on concrete or masonry surface. Each size shall be kept separated with wooden or steel or concrete or masonry bulk-heads or in separate stacks and sufficient care shall be taken to prevent the material at the edges of the stock piles from getting intermixed. Stacks of fine and coarse aggregates shall be kept sufficiently apart with proper arrangement of drainage. The aggregates shall be stored in easily measurable stacks of suitable depths as may be directed by the Engineer.

2.6.4 Reinforcement

Reinforcing steel shall be stored consignment-wise and size wise off the

ground and under cover, if desired by the Engineer. It shall be protected from rusting, oil, grease and distortions. If necessary, the reinforcing steel may be coated with cement wash before stacking to prevent scale and rust. The stacks shall be easily measurable. Steel needed for immediate use shall only be removed from storage.

2.7 Quality Control

Contractor shall establish and maintain quality control for different items of work and materials as may be directed by the Engineer to assure compliance with contract requirements and maintain and submit to the Engineer records of the same.

The quality control operation shall include but not be limited to the following items of work:

(a)	Admixture	:	Type, quantity, physical and chemical properties that affect strength, workability and durability of concrete.
		:	For air entraining admixtures, dosage to be adjusted to maintain air contents within desirable limits
(b)	Aggregate	:	Physical, chemical and mineralogical qualities. Grading, moisture content and impurities.
(c)	Water	:	Impurities tests.
(d)	Cement	:	Tests to satisfy relevant IS Specifications (only association with Owner's tests, if the supply is made by Owner).
(e)	Formwork	:	Material, shapes, dimensions, lines, elevations, surface finish, adequacy of form, ties, bracing and shoring and coating.

(f)	Reinforcement	:	Shapes, dimensions, length of plices, clearances, ties and supports. Quality and requirement of welded splices. Material tests or certificates to satisfy relevant IS Specification
(g)	Grades of concrete	:	Usage and mix design, testing of all properties.
(h)	Batching & Mixing	:	Types and capacity of plant, concrete mixers and transportation equipment.
(i)	Joints	:	Locations of joints, water stops and filler materials. Dimension of joints, quality and shape of joint material and splices.
(j)	Embedded and Anchorage Items	:	Material, shape, location, setting.
(k)	Placing	:	Preparation, rate of pouring, weather limitations, time intervals between mixing and placing and between two successive lifts, covering over dry or wet surfaces, cleaning and preparation of surfaces on which concrete is to be placed, application of mortar/slurry for proper bond, prevention of cold joint, types of chutes or conveyors.
(l)	Compaction	:	Number of vibrators, their prime mover, frequency and amplitude of vibration, diameter and weight of vibrators, duration of vibration, hand-spreading, rodding and tamping.
(m)	Setting of base & Beaming plates	:	Lines, elevations and bedding mortar.
(n)	Concrete Finishes	:	Repairs of surface defects, screening, floating, steel trowelling and brooming, special finishes.
(o)	Curing	:	Methods and length of time.

Copies of records and tests for the items noted above, as well as, records of corrective action taken shall be submitted to the Engineer for approval as may be desired.

3.0 INSTALLATION

All installation requirements shall be in accordance with IS:456 and as supplemented or modified herein or by other best possible standards where the specific requirements mentioned in this section of the specification do not cover all the aspects to the full satisfaction of the Engineer.

3.1 WASHING AND SCREENING OF AGGREGATES

Washing and Screening of coarse aggregate shall be carried out to remove fines, dirts or other deleterious materials.

Washing of fine aggregate shall not be allowed, Fine aggregates shall be screened only to remove dirt or other deleterious materials.

However, all washing & screening of aggregates shall be carried out by approved means to ensure compliance with the aggregate specification.

3.2 ADMIXTURE

All concrete shall be designed for normal rate of setting and hardening at normal temperature. Variations in temperature and humidity under different climatic conditions will affect the rate of setting and hardening, which will, in turn, affect the workability and quality of the concrete.

Admixtures may be permitted to be used in accordance with IS: 456 to modify the rate of hardening, to improve workability or as an aid to control concrete quality. The Engineer reserves the right to require laboratory test or use test data, or other satisfactory reference before granting approval. The admixture shall be used strictly in accordance with the manufacturer's directions and/or as directed by the Engineer.

3.3 GRADES OF CONCRETE

Structural concrete shall be of M30 grade and for other part of the work shall be as shown on the drawing as per grade classification of IS-456. In case of liquid retaining structures, IS:3370 will be followed.

3.4 PROPORTIONING AND WORKS CONTROL

3.4.1 General

Proportioning of ingredients of concrete shall be made by any of the two following methods as directed by the Engineer:

(a) With preliminary tests by designing the concrete mix. Such concrete shall be called 'Design Mix Concrete'.

(b) Without preliminary tests adopting nominal concrete mix. Such concrete shall be called 'Nominal Mix Concrete'.

As far as possible, design mix concrete shall be used on all concrete works. Nominal mix concrete, in grades permitted in accordance with IS:456, may be used if shown on drawings or approved by the Engineer. In all cases the proportioning of ingredients and works control shall be in accordance with IS:456 and shall be adopted for use after the Engineer is satisfied regarding its adequacy and after obtaining his approval in writing.

3.4.2 Mix Design Criteria

Concrete mixes will be designed by the Contractor to achieve the strength, durability and workability necessary for the job, by the most economical use of the various ingredients. In general, the design will keep in view the following considerations:

(a) Consistent with the various other requirements of the mix, the quantity of water should be kept at the lowest possible level.

(b) The nominal maximum size of coarse aggregate shall be as large as possible within the limits specified.

(c) The various fractions of coarse and fine aggregates should be mixed in such a proportion as to produce the best possible combined internal grading giving the densest and most workable mix.

(d) Chemical admixtures may be used to modify the rate of hardening, to improve workability (maintaining low water - cement ratio) or as an aid to control concrete quality.

(e) The finished concrete should have adequate durability in all conditions, to withstand satisfactorily the weather and other destructive agencies which it is expected to be subjected to in actual service.

The requirement of adequate structural strength is catered for by the choice of proper grade of concrete by the Engineer. The Contractor will strictly abide by the same in his design of concrete mix installation. Notwithstanding anything mentioned in various tables given in IS:456 giving specific values and degrees of workability for different condition of concrete placing, minimum cement content and maximum water-cement ratio for concrete exposed to sulphate attack and for concrete to ensure durability under different condition of exposure, strength requirement for different grades of concrete, proportion for nominal mix concrete, values given in the tables in IS:456, shall be followed.

Various trials shall be given by the contractor with specific cement content on each trial. In some cases, plasticizers and other admixtures may be necessary to achieve the desired results.

TABLE – I

STRENGTH REQUIREMENT OF CONCRETE

Specified Characteristic Compressive Grade of concrete strength of 15cm Cubes at 28 days conducted in accordance with IS:516 (All values in N/Sq.mm)

M – 10	10
M – 15	15
M – 20	20
M – 25	25
M – 30	30
M – 35	35
M – 40	40

Note:

1. Nominal mix concrete of proportions 1:4:8 or 1:3:6 may be used as lean concrete for simple foundations for masonry walls, below the reinforced concrete foundations and mass filling. These mixes need not be designed.

TABLE – II

MIX PROPORTION (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORK ABILITY WITH DIFFERENT VALUES OF WATER – CEMENT RATIO (FOR GUIDANCE) CEMENT / TOTAL AGGREGATE RATIOS

	WORKABILITY	WATER / CEMENT / RATIO	RATIO BY WEIGHT OF CEMENT OF GRAVEL AGGREGATE		RATIO BY WEIGHT OF CEMENT OF CRUSHED STONE AGGREGATE	
			20 mm size	38 mm size	20 mm size	38 mm size
(a)	Very low	0.4	01:04.8	01:05.3	01:04.5	01:05.0
(b)	Slump	0.5	01:07.2	01:07.7	01:06.5	01:07.4
(c)	0-25 mm	0.6	01:09.4	1:10	01:07.8	01:09.6
		0.7	1:10	1:12	01:08.7	01:10.6
(a)	Low	0.4	01:03.9	01:04.5	01:03.5	01:04.0
(b)	Slump	0.5	01:05.5	01:06.7	01:05.0	01:05.5
(c)	25-50 mm	0.6	01:06.8	01:07.4	01:06.3	01:07.0
(d)		0.7	01:08.0	01:08.5	01:07.4	01:08.0
(a)	Medium	0.4	01:03.5	01:03.8	01:03.1	01:03.6
(b)	Slump	0.5	01:04.8	01:05.7	01:04.2	01:05.0
(c)	50-100 mm	0.6	01:06.0	01:07.3	01:05.2	01:06.2
(a)	High	0.4	01:03.2	01:03.5	01:02.9	01:03.3

(b)	Slump	0.5	01:04.4	01:05.2	01:03.9	01:04.6
(c)	100-175 mm	0.6	01:05.4	01:06.7	01:04.7	01:05.7
		0.7	01:06.2	01:07.4	01:05.5	01:06.5

NOTES:

1. Notwithstanding anything mentioned above, the cement/Total aggregate ratio is not to be increased beyond 1:9.0 without specific permission of the Engineer.

2. It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water- cement ratios which may be required to be used in mass concrete work only.

3. The above figures are for guidance only, the actual cement/aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes.

3.5 STRENGTH REQUIREMENTS

The strength requirements of both design mix and nominal mix concrete where ordinary Portland Cement or Portland slag cement is used, shall be as per Table-2 of IS:456. All other relevant clauses of IS:456 shall also apply.

3.6 MINIMUM CEMENT CONTENT

The minimum cement content for each grade of concrete shall be as per Table -5 of IS : 456.

3.7 WATER-CEMENT RATIO

The choice of water-cement ratio in designing a concrete mix will depend on-

(a) The requirement of strength.

(b) The requirement of durability.

3.7.1 Strength Requirement

In case of 'Design Mix Concrete', the water-cement ratio of such value as to give acceptable test results as per IS: 456 will be selected by trial and error. The values of water-cement ratios for different grade and mix designs will have to be established after conducting sufficiently large number of preliminary tests in the laboratory to the satisfaction of the Engineer. Frequent checks on test will have to be carried out and the water-cement ratios will be revised if the tests produce unsatisfactory results. Notwithstanding anything stated above the Contractor's responsibility to produce satisfactory test results and to bear all the consequences in case of default remains unaltered.

In case of nominal mix concrete, proportions for different grades of concrete is specified in Table-9 of IS:456 and no tests are necessary. The acceptance test criteria for nominal mix concrete shall be as per IS: 456.

3.7.2 Durability Requirement

Table-5 of IS:456 gives the maximum water-cement ratio permissible from the point of view of durability of concrete subjected to adverse exposure to weather, sulphate attacks, and contact with harmful chemicals. Impermeability may also be an important consideration.

Whenever the water-cement ratio dictated by durability consideration is lower than that required from strength criterion, the former shall be adopted.

In general the water cement ratio between 0.4 and 0.45 will be desirable to satisfy the durability requirement and from the consideration of impermeability of concrete. The contractor may propose lower water cement ratio as mentioned above by addition of a suitable plasticizer/super-plasticizer. However the contractor has to propose specifically along with field trials in the event of lower cement content if found suitable along with a plasticizer. It will be preferable to use Melamine based plasticizer

3.8 WORKABILITY

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedment and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. The usual limits of consistency for various types of structures are given below:

TABLE - III

LIMITS OF CONSISTENCY

Degree of workability	Slump in mm with Standard Cone as per IS:1199		Use for which concrete is suitable.
	Min.	Max.	
Very low	0	25	Large Mass concrete structure with heavy compaction equipment, roads and like.
Low	25	50	Uncongested wide and shallow R.C.C. structures.
Medium	50	100	Deep but wide R.C.C. structures with congestion or reinforcement and inserts
High	100	150	Very narrow and deep R.C.C. Structures with congestion due to reinforcement and inserts.

(NOTE: Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer)

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively where facilities exist or if required by the Engineer, the compacting factor test in accordance with IS:1199.

3.9 SIZE OF COARSE AGGREGATES

The maximum size of coarse aggregates for different locations shall be as follows unless otherwise directed by the Engineer:-

(a)	Very narrow space	:	12 mm
(b)	Reinforced concrete except foundation	:	20 mm
(c)	Ordinary Plain concrete and Reinforced concrete foundations	:	40 mm
(d)	Mass concrete	:	80 mm
(e)	Mass concrete in very large structure	:	150 mm

Grading of coarse aggregates for a particular size shall conform to relevant I.S. Codes and shall also be such as to produce a dense concrete of the specified proportions, strength and consistency that will work readily into position without segregation.

Coarse aggregate will normally be separated into the following sizes and stacked separately in properly designed stockpiles :

150 mm to 80 mm, 80 mm to 40 mm, 40 mm to 20 mm and 20 mm to 5 mm. In certain cases it may be necessary to further split the 20 mm to 5 mm fraction into 20 mm to 10 mm and 10 mm to 5 mm fractions.

This separation of aggregates in different size fractions is necessary so that they may be remixed in the desired proportion to arrive at a correct internal grading to produce the best mix.

3.10 MIXING OF CONCRETE

Concrete shall always be mixed in mechanical mixer unless specifically approved by the Engineer for concrete to be used in unimportant out of the way locations in small quantities. Water shall not normally be charged into the drum of the mixer until all the cement and aggregates constituting the batch are already in the drum and mixed for at least one minute. Mixing of each batch shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency, but in no case shall mixing be done for less than 2 (two) minutes and at least 40 (forty) revolutions after all the materials and water are in the drum. When absorbent aggregates are used or when the mix

is very dry, the mixing time shall be extended as may be directed by the Engineer. Mixers shall not be loaded above their rated capacity as this prevents thorough mixing.

The entire contents of the drum shall be discharged before the ingredients for the next batch are fed into the drum. No partly set or remixed or excessively wet concrete shall be used. Such concrete shall be immediately removed from site. Each time the work stops, the mixer shall be thoroughly cleaned & when the next mixing commences, the first batch shall have 10% additional cement to allow for loss in the drum.

Regular checks on mixer efficiency shall be carried out as directed by the Engineer as per IS: 4634 on all mixers employed at site. Only those mixers whose efficiencies are within the tolerances specified in IS: 1791 will be allowed to be employed.

Ingradients for design mix concrete shall be measured by weight. For small jobs portable swing weigh Bashers conforming to IS: 2722 may be used.

Batching plant conforming to IS: 4925 shall be used for large jobs. The accuracy of the measuring equipment shall be within + 2% of the quantity of Cement, water or total aggregates being measured and within + 5% of the quantity of any admixture being used. The batching equipment shall be fitted with an accurate mechanism for weighing separately the cement, fine aggregate and coarse aggregate. Water may be measured by volume or by weight. All measuring equipment should be maintained in a clean serviceable condition, and their accuracy shall be checked periodically.

Mechanical / electrical control shall be provided on the mixing equipment to ensure the batch cannot be discharged until approved mixing time has elapsed and the entire batch shall be discharged before the mixer is recharged.

Where admixtures are employed, separate containers & measuring devices shall be used.

For minor concreting works, batching by volume according to specific weight may be permitted by the Engineer. In that case the whole bags of cement shall be used and gauge boxes used for measuring aggregates.

When hand mixing is permitted by the Engineer, it shall be carried out on a water-tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand-mixing, 10% extra cement shall be added to each batch.

3.11 CONVEYING CONCRETE

Concrete shall be handled and conveyed from the place of mixing to the place of laying as rapidly as practicable by approved means and placed and compacted in the final position before the initial setting of the cement starts. Concrete should be conveyed in such a way as will prevent segregation or loss of any of the ingredients. For long distance haulage, agitator cars of approved design will be used. If, in spite of all precautions, segregation does occur during transport, the concrete shall be properly re-mixed before placement. During very hot or cold weather, if directed by the Engineer, concrete shall be transported in deep containers which will reduce the rate of loss of water by evaporation or loss of heat. If necessary, the container may have to be covered and insulated. Conveying equipments for concrete shall be well maintained and thoroughly cleaned before commencement of concrete mixing. Such equipments shall be kept free from set concrete.

3.12 PLACING AND COMPACTING CONCRETE

Where specifically covered, the relevant I.S. Code will be followed for the procedure of surface preparation, placement, consolidation, curing, finishes, repairs and maintenance of concrete. If, however, there is no specific provision in the relevant I.S. Code for any particular aspect of work, any other standard Code of practice, as may be specified by the Engineer, will be adopted. Concrete may have to be placed against the following types of surfaces:

(a) Earth foundation

(b) Rock foundation

(c) Formwork

(d) Construction joint in concrete or masonry

The surface on or against which concrete is to be placed has to be cleaned thoroughly. Rock or old construction joint has to be roughened by wire brushing, chipping, sand blasting or any other approved means for proper bond. All cuttings, dirt, oil, foreign and deleterious material, laitance, etc. are to be removed by air water jetting or water at high pressure. All excavated areas for foundations, ring beams, plinths, pile caps etc. shall be rammed & consolidated properly before blinding with nominal mix plain concrete, as per drawing and / or direction of the Engineer and shall be allowed to cure prior to setting out steel fixing, shuttering and concrete pouring for the main structural element.

Formwork, reinforcement, preparation of surface, embedment, joint seals etc., shall be approved in writing by the Engineer before concrete is placed. As far as possible, concrete shall be placed in the formwork by means approved by the Engineer and shall not be dropped from a height or handled in a manner which may cause segregation. Any drop over 1500 mm shall have to be approved by the Engineer.

Rock foundation or construction joint will be kept moist for at least 72 hours prior to placement. Concrete will be placed always against moist surface but never on pools of water. In case the foundation cannot be dewatered completely, special procedure and precaution, as directed by the Engineer will have to be adopted.

Formwork will be cleaned thoroughly and smeared lightly with form oil or grease of approved quality just prior to placement.

A layer of mortar of thickness 12 mm of the same or less w/c ratio and the same proportion as that of the concrete being placed and cement slurry will be spread thoroughly on the rock foundation or construction joint just prior to placement of concrete. The cost of application of such cement slurry and mortar will be deemed to be included.

After concrete has been placed, it shall be spread, if necessary and thoroughly compacted by approved mechanical vibration to maximum subsidence without segregation and thoroughly worked around shape. Vibrators shall not be used for pushing concrete into adjoining areas.

Vibrators must be operated by experienced workmen and the work carried out as per relevant IS Code of Practice. In thin members with heavy congestion of reinforcement or other embedment, where effective use of internal vibrator is, in the opinion of the Engineer, doubtful, in addition to immersion vibrators the contractor may have to employ form vibrators conforming to IS: 4656. For slabs and other similar structures, the contractor will additionally employ screed vibrator as per IS: 2506. Hand tamping may be allowed in rare cases, subject to the approval of the Engineer. Care must be taken to ensure that the inserts, fixtures, reinforcement and formwork are not displaced or distorted during placing and consolidation of concrete.

The rate of placement of concrete shall be such that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable. No concrete shall be placed in open, during rains. During rainy season, no placement in the open is to be attempted unless sufficient tarpaulins or other similar protective arrangement for completely covering the still green concrete from rain is kept at the site of placement. If there has been any sign of washing of cement and sand, the entire affected concrete shall be removed immediately. Suitable precautions shall be taken in advance to guard against rains before leaving the fresh concrete unattended. No accumulation of water shall be permitted on or around freshly laid concrete.

The size of the concrete pours must be carefully considered prior to commencement to ensure the structural elements are poured in on continuous shift to avoid cold joints.

Slabs, beams and similar members shall be poured in one operation, unless otherwise instructed by the Engineer. Moulding, throating, drip course, etc., shall be poured as shown on the drawings or as directed by the Engineer. Holes shall be provided and bolts, sleeves, anchors, fastenings or other fixtures shall be embedded in concrete as shown on the drawings or as directed by the Engineer. Any deviation there from shall be set right by the Contractor as instructed by the Engineer.

In case the forms or supports get displaced during or immediately after the placement and bring the concrete surface out of alignment beyond tolerance limits, the Engineer may direct to remove the portion and

reconstruct or repair the same.

The Engineer shall decide upon the time interval between two placements of concrete of different ages coming in contact with each other, taking in consideration the degree of maturity of the older concrete, shrinkage, heat dissipation and the ability of the older concrete to withstand the load imposed upon it by the fresh placement.

Once the concrete is deposited, consolidated and finished in its final position, it shall not be distributed.

3.13 CONSTRUCTION JOINTS AND COLD JOINTS

3.13.1 Construction Joints

It is always desirable to complete any concrete structure by continuous pouring in one operation. However, due to practical limitation of methods and equipment and certain design considerations, construction joints are formed by discontinuing concrete at certain predetermined stages. These joints will be formed in a manner specified in the drawings/ Instruction.

Vertical construction joints will be made with rigid stop-board forms having slots for allowing passage of reinforcement rods and any other embedments and fixtures that may be shown. Next stage concrete shall be placed against construction joint as per clause 3.12. For water retaining structures and leak-proof buildings suitable approved water bars will be installed at the construction joints.

Where the locations of the joints are not specified, it will be in accordance with the following:

(a) In a column, the joint shall be formed 75 mm below the lowest soffit of the beam framing into it.

(b) Concrete in a beam shall preferably be placed without a joint, but if provision of a joint is unavoidable, the joint shall be vertical and within the middle third of the span.

(c) A joint in a suspended floor slab shall be vertical and within the middle third of the span and at right angles to the principal reinforcement.

(d) Feather-edges in concrete shall be avoided while forming a joint.

(e) A construction joint should preferably be placed in a low-stress zone and at right angles to the direction of the principal stress.

(f) In case the Contractor proposes to have a construction joint anywhere to facilitate his work, the proposal should be submitted well in advance to the Engineer for study and approval without which no construction joint will be allowed.

3.13.2 Cold Joint

An advancing face of a concrete pour, which could not be covered by fresh concrete before expiry of initial setting time (due to an unscheduled stoppage or delay on account of breakdown in plant, inclement weather, low rate of placement or any other reason), is called a cold joint. The Contractor should always remain vigilant to avoid cold joints.

If, however, a cold joint is formed due to unavoidable reasons, the following procedure shall be adopted for treating it:

(a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly against the old surface. The old concrete should be covered by fresh concrete as quickly as possible and the joint thoroughly and systematically vibrated.

(b) In case concrete has hardened a bit more than (a) but can still be easily removed by a light hand pick, the surface will be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. A rich mortar layer 12 mm in thickness, will be placed on the cold joint fresh concrete shall be placed on the mortar layer and the joint will be thoroughly and systematically vibrated penetrating the vibrator deep into the old layer of concrete.

(c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, the joint will be left to harden for at least 12 - 24 hrs. It will then be treated as a regular construction joint, after cutting the concrete to required shape and preparing the surface as described under clause 3.12.

3.14 REPAIRS, FINISHES AND TREATMENT OF CONCRETE SURFACES

3.14.1 Adequate and sound concrete surfaces, whether formed or unformed, can be obtained by employing a concrete mix of proper design, competent formwork, and appropriate methods of handling, placing and consolidation by experienced workmen.

Unsound concrete resulting from improper mix design, incompetent methods, equipment and formwork, poor workmanship and protection will not be accepted and will have to be dismantled, removed and replaced by sound concrete. The Engineer may, at his sole discretion, allow to retain concrete with minor defects provided the Contractor is able to repair it by approved methods. All concrete work shall be inspected by the Contractor immediately after the forms are removed and he will promptly report occurrence of any defects to the Engineer. All repair works will be carried out as per the instructions and in the presence of the Engineer or his representative. Generally, repair work will consist of any or all of the following operations :

(a) Sack rubbing with mortar and stoning with carborundum stone.

(b) Cutting away the defective concrete to the required depth and shape.

(c) Cleaning of reinforcement and embedments. It may be necessary to provide an anti-corrosive coating on the reinforcement.

(d) Roughening by sand blasting or chipping.

(e) Installing additional reinforcement/welded mesh fabric.

(f) Dry packing with stiff mortar.

(g) Plastering, guniting, shotcreting etc.

(h) Placing and compacting concrete in the void left by cutting out defective concrete.

(i) Grouting with cement sand slurry of 1:1 mix.

(j) Repairing with a suitable mortar either cement or resin modified mortar.

(k) Polyer modified patching and adhesive repair mortar for beams & columns.

3.14.2 Finishing Unformed Surface

A few typical and common cases of treatment of concrete surface are cited below:

(a) Floor

Whenever a non-integral floor finish is indicated, the surface of reinforcement concrete slab shall be struck off at the specified levels and slopes and shall be finished with a wooden float fairly smooth removing all laitance. No over trowelling, to obtain a very smooth surface, shall be done as it will prevent adequate bond with the subsequent finish. If desired by the Engineer, the surface shall be scored and marked to provide better bond.

Where monolithic finish is specified or required, concrete shall be compacted and struck off at the specified levels and slopes with a screed, preferably a vibrating type and then floated with a wooden float. Steel trowelling by hand or by rotary power float is then started after the moisture film and shine have disappeared from the surface and after the concrete has hardened enough to prevent excess of fines and water to rise to the surface but not hard enough to prevent proper finishing of aberrations. Steel trowelling properly done will flatten and smoothen sandy surface left by wooden floats and produce a dense surface free from blemishes,

ripples and trowel marks. A fine textured surface that is not slick and can be used where there is likelihood of spillage of oil or water can be obtained by trowelling the surface lightly with a circular motion after initial trowelling keeping the steel trowel flat on the surface.

To provide a better grip the Engineer may instruct marking the floor in a regular geometric pattern after initial trowelling.

(b) Beams, Columns & Walls

If on such or any other concrete structure it is intended to apply plaster or such concrete surfaces against which brickwork or other allied works are to be built, the Contractor shall hack the surface adequately as soon as the form is stripped off so that proper bond can develop. Pattern, adequacy and details of such hacking shall meet with the approval of the Engineer, who shall be informed to inspect such surfaces before they are covered up.

3.15 PROTECTION AND CURING OF CONCRETE

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected against contamination from falling earth during and after placing. Concrete placed in ground containing deleterious substances, shall be protected from contact with such ground, or with water draining from such ground, during placing of concrete and for a period of at least three days or as otherwise instructed by the Engineer. The ground water around newly poured concrete shall be kept to an approved level by pumping out or other adequate means of drainage to prevent floatation or flooding. Steps, as approved by the Engineer, shall be taken to protect immature concrete from damage by debris, excessive loadings, vibration, abrasion, mixing with earth or other deleterious materials, etc. that may impair the strength and durability of the concrete.

As soon as the concrete has hardened sufficiently, it shall be covered either with sand, polythene sheet, hessian, canvas or similar materials and kept continuously wet for at least 14 (fourteen) days after final setting. Curing by continuous sprinkling of water will be allowed if the Engineer is satisfied with the adequacy of the arrangements made by the Contractor.

If permitted by the Engineer, curing compound like "ANTISOLE (WP)" may be used for prevention of premature water loss in concrete and thereby effecting curing of concrete. This type of curing compound shall be sprayed on newly laid concrete surfaces to form thin film barrier against premature water loss without disturbances to normal setting action. The curing compound shall comply with ASTM requirements for acceptance.

The curing compound shall be applied following the final finishing operation and immediately after disappearance of water sheen from concrete surface.

It is important not to apply the curing compound when standing water is still present on concrete.

The contractor shall arrange for the manufacturer's supervision.

The Contractor shall remain extremely vigilant and employ proper equipment and workmen under able supervision for curing. The Engineer's decision regarding the adequacy of curing is final. In case any lapse on the part of the Contractor is noticed by the Engineer, he will inform the Contractor or his supervisor verbally or in writing to correct the deficiency in curing. If no satisfactory action is taken by the Contractor within 3 (three) hours of issuance of such instruction, the Engineer will be at liberty either to employ sufficient means through any agency to make good the deficiency and entirely at the discretion of the Engineer.

3.16 REINFORCEMENT

Mild steel round bars, cold twisted and deformed bars as medium tensile or high yield strength steel, plain hard drawn steel wire fabric etc., will be used as reinforcement as per drawings and directions. In an aggressive environment an anti-corrosive coating on the reinforcement may be provided as per IS: 9077, as shown on the drawing or as directed by the Engineer.

3.16.1 Bar Bending Schedules

The Contractor shall submit to the Engineer for approval Bar Bending Schedules with working drawings in triplicate, showing clearly the

arrangements proposed by the Contractor to match available stock of reinforcing steel, within one month of receipt of the Letter of Intent or of the receipt of the relevant design drawings, whichever is later. Upon receipt of the Engineer's final approval of the Bar Bending Schedule and drawings, the Contractor shall submit 6 (six) prints of the final drawings with one reproducible print after incorporating necessary modifications or corrections, for final record and distribution. Approval of such detailed drawings by the Engineer shall not relieve the Contractor of his responsibility for correctness nor of any of his obligations to meet the other requirements of the Contract.

3.16.2 Cleaning

All steel for reinforcement shall be free from loose scales, oil, grease, paint or other harmful matters immediately before placing the concrete.

3.16.3 Cutting & Bending of Reinforcement

Unless otherwise specified, reinforcing steel shall be bent in accordance with the procedure specified in IS:2502 or as approved by the Engineer. Bends and shapes shall comply strictly with the dimensions corresponding to the approved Bar Bending Schedules. Bar Bending Schedules shall be rechecked by the Contractor before any bending is done.

No reinforcement shall be bent when already in position in the work, without approval of the Engineer, whether or not it is partially embedded in concrete. Bars shall not be straightened in a manner that will injure the material. Re bending can be done only if approved by the Engineer. Reinforcing bars above 16 mm diameter shall be bent by machine producing a gradual and even motion. Bars of 16 mm or below may be bent by hand. All the bars shall be cold bent unless otherwise approved. Bending hot at a cherry-red heat (not exceeding 845°C) may be allowed under very exceptional circumstances except for bars whose strength depends on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcing bars, whether high yield or mild steel shall be cut using either hand held shears, guillotines or foot operated pneumatic cutters. Cutting bars using cold chisels may be allowed by the Engineer at exceptional cases.

3.16.4 Placing in Position

All reinforcements shall be accurately fixed and maintained in position as shown on the drawings by such approved and adequate means like mild steel chairs and/or concrete spacer blocks irrespective of whether such supports are payable or not. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by No. 20 G annealed soft iron wire. Tack welding of bars should not be done unless permitted by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers.

Before actual placing, the Contractor shall study the drawings thoroughly and inform the Engineer in case he feels that placement of certain bars is not possible due to congestion. In such cases he should not start placing any bar before obtaining clearance from the Engineer.

3.16.5 Welding

Normal bond laps in reinforcement may be placed by lap or butt welding reinforcement bars, if asked by the Engineer, under certain conditions. The work should be done with suitable safeguards in accordance with relevant Indian Standards for welding of mild steel bars used in reinforced concrete construction as per IS:2751 and IS:456. Welded mesh fabrics conforming to IS: 1566 may also be used if specified in the Schedule of Items and Drawings.

3.16.6 Control

The placing of reinforcements shall be completed well in advance of concrete pouring. Immediately before pouring, the reinforcement shall be examined by the Engineer for accuracy of placement and cleanliness. Necessary corrections as directed by him shall be carried out. Laps and anchorage lengths of reinforcing bars shall be in accordance with IS: 456, unless otherwise specified. If the bars in a lap are not of the same diameter, the smaller will guide the lap length. The laps shall be staggered as far as practicable and as directed by the Engineer. Arrangements for

placing concrete shall be such that reinforcement in position do not have to bear extra load and get disturbed.

The cover for concrete over the reinforcements shall be as shown on the approved drawings unless otherwise directed by the Engineer. Where concrete blocks are used for ensuring the cover and positioning reinforcement, they shall be made of mortar not leaner than 1 (one) part cement to 2 (two) parts sand by volume and cured in a pond for at least 14 (fourteen) days. The type, shape, size and location of the concrete blocks shall be as approved by the Engineer.

3.17 COLD WEATHER CONCRETING

When conditions are such that any operation of concreting may be expected to be done at 5Deg.C atmospheric temperature or below the work shall conform to the requirement of Clause 14 of IS:456 and IS:7861. (Part. II).

3.18 HOT WEATHER CONCRETING

When depositing concrete in very hot weather, the Contractor shall take all precautions as per IS:7861 (Part-I) and stagger the work to the cooler parts of the day to ensure that the temperature of wet concrete used in massive structures does not exceed 40 Deg.C while placing. Positive temperature control by pre cooling, post cooling or any other method, if required, will be specified`.

3.19 CONCRETING UNDER WATER

When it is necessary to deposit concrete under water it shall be done in accordance with the requirements of clause 14 of IS:456.

3.20 FORM WORK

3.20.1 General

Formwork shall conform to the shape, grade, lines, levels and dimension as shown on the drawings. The contractor shall prepare design & working drawings for formwork & temporary support system for important

structures and get them approved by the Engineer prior to commencement of actual work.

Materials used for the formwork inclusive of the supports and centering shall be capable of withstanding the working load and remain undistorted throughout the period it is left in service. All supports and scaffolds should be manufactured from structural or tubular steel except when specifically permitted otherwise by the Engineer.

The centering shall be true to vertical, rigid and thoroughly braced both horizontally and diagonally. Rekers are to be used where forms are to support inclined members. The forms shall be sufficiently strong to carry without undue deformation, the dead weight of the concrete as a liquid as well as the working load, in case the Contractor wishes to adopt any other design criteria, he has to convince the Engineer about its acceptability before adopting it. Where the concrete is vibrated, the formwork shall be strong enough to withstand the effects of vibration without appreciable deflection, bulging, distortion or loosening of its components. The joints in the formwork shall be sufficiently tight to prevent any leakage of slurry or mortar.

To achieve the desired rigidity, tie bolts, spacer blocks, tie wires and clamps as approved by the Engineer shall be used but they must in no way impair the strength of concrete or cause stains or marks on the finished surface. Where there are chances of these fixtures being embedded, only mild steel or concrete of adequate strength shall be used. Alternatively, except in case of water retaining structures through rods and the tie bolts shall be sleeved with PVC conduits to allow retraction of the ties on removal of the shutters. Where required, the annulus of the conduits will be filled with expanding mortar to seal the void. Bolts passing completely through liquid retaining walls/slabs for the purpose of securing and aligning the formwork shall not be used.

The formwork shall be such as to ensure a smooth uniform surface free from honeycombs, air bubbles, bulges, fins and other blemishes. Any blemish or defect found on the surface of the concrete must be brought to the notice of the Engineer immediately and rectified as directed by him.

For exposed interior and exterior concrete surfaces of beams, columns and wall, plywood or other approved form shall be thoroughly cleaned and tied together with approved corrosion- resistant devices. Rigid care shall be exercised in ensuring that all column forms are plumb and true and thoroughly cross braced to keep them so. All floor and beam centering shall be crowned not less than 8 mm in all directions for every 5 metres span. Unless specifically described on the drawings or elsewhere to the contrary, bevelled forms 25 mm by 25 mm shall be fixed in the form-work at all corners to provide chamfering of the finished concrete edges. The formwork should lap and be secured sufficiently at the lift joints to prevent bulges and offsets.

Temporary openings for cleaning, inspection and for pouring concrete shall be provided at the base of vertical forms and at other places, where they are necessary and as may be directed by the Engineer. The temporary openings shall be so formed that they can be conveniently closed when required, during pouring operations without leaving any mark on the concrete.

3.20.2 Cleaning and Treatment of Forms

All parts of the forms shall be thoroughly cleaned of old concrete, wood shavings, saw dust, dirt and dust sticking to them before they are fixed in position. All rubbish, loose concrete, chippings, shavings, saw dust etc. shall be scrupulously removed from the interior of the forms before concrete is poured. Compressed air jet and/or water jet along with wire brushes, brooms etc. shall be used for cleaning. The inside surface of the formwork shall be treated with approved non-staining oil based shutter release agent like “Separol/Sika form oil/Siparol Concentrate" before it is placed in position. Care shall be taken that oil or other compound does not come in contact with reinforcing steel or construction joint surfaces. They shall not be allowed to accumulate at the bottom of the formwork. The oiling of the formwork will be inspected just prior to placement of concrete and redone wherever necessary.

3.20.3 Design

The formwork shall be so designed and erected that the forms for slabs and the sides of beams, columns and walls are independent of the soffits of

beams and can be removed without any strain to the concrete already placed or affecting the remaining formwork. Removing any props or re propping shall not be done except with the specific approval of the Engineer. If formwork for column is erected for the full height of the column, one side shall be left open and built up in sections, as placing of concrete progress. Wedges, spacer bolts, clamps or other suitable means shall be provided to allow accurate adjustment and alignment of the formwork and to allow it to be removed gradually without jarring the concrete.

The design of formwork shall take into account all vertical and lateral loads that the forms will carry or be subjected to during the construction process. Besides weight and pressures of reinforced concrete and weight of the forms themselves, the design shall consider loading due to unsymmetrical placement of concrete; impact from dumping of concrete; movement of men and construction equipment; wind action and any other imposed load during construction. The contractor shall assess the magnitude of vertical live load to be taken for design of formwork duly considering his method, sequence and rate of pour of concrete. However, minimum design vertical live load to be considered shall be 750 kg/sqm excluding weight of concrete.

3.20.4 Inspection of Forms

Casting of Concrete shall start only after the formwork has been inspected and approved by the Engineer. The concreting shall start as early as possible within 3 (three) days after the approval of the formwork and during this period the formwork shall be kept under constant vigilance against any interference. In case of delay beyond three days, a fresh approval from the Engineer shall be obtained.

3.20.5 Removal of Forms

Before removing any formwork, the Contractor must notify the Engineer well in advance to enable him to inspect the concrete if he so desires. The Contractor shall record on the drawing or in any other approved manner, the date on which concrete is placed in each part of the work and the date on which the formwork is removed there from and have this record checked and countersigned by the Engineer regularly.

The Contractor shall be responsible for the safe removal of the formwork and any work showing signs of damage through premature removal of formwork or loading shall be rejected and entirely reconstructed by him. The Engineer may, however, instruct to postpone the removal of formwork if he considers it necessary.

Forms for various types of structural components shall not be removed before the minimum periods specified herein and the removal after the minimum periods shall also be subject to the approval of the Engineer in each case.

TABLE – IV

SCHEDULE OF REMOVAL OF FORM

		Ordinary Portland Cement Concrete				**Rapid Hardening Portland Cement Concrete**			
	Part of Structure	Temperature Deg.C				Temperature Deg.C			
		Above 40 Deg.- 20 Deg.-Below 40 Deg. 20 Deg. 5 Deg. 5 Deg.				Above 40 Deg.- 20 Deg. Below 40 Deg. 20 Deg. 5 Deg. 5 Deg.			
		Days	Days	Days	Days	Days	Days	Days	Days
(a)	Columns & Walls	2	1	1	Do not remove forms until site cured test specimen develop at least 50% of the specified 28 days strength	1	1	1	Do not remove forms until site cured test specimen develop at least 50% of the specified 28 days strength
(b)	Beam sides	3	2	3		2	1	1	
(c)	Slabs, 125mm	10	7	8		7	4	5	
(d)	Slabs over 125 thick and soffit of minor beams	18	14	16		12	8	9	
(e)	Soffit of main Beams	24	21	22		14	10	12	

Wherever exposed surfaces of concrete can be effectively sealed to prevent loss of water, the periods specified for temperature above 40 Deg.C can be reduced to those of the temperature range of 20 Deg.C to 40 Deg.C subject to approval of the Engineer.

Construction joints in beams, if required to be provided, will be located within the middle third of span according to clause 3.13.1(b) of this specification. In such cases, however, entire span of beam shall have to

be kept supported by formwork till its removal for the portion of beam, cast at a later date, is due and so approved by the Engineer.

If any type of cement other than ordinary portland cement and Rapid hardening portland cement is used the time of removal or forms shall be revised as approved by the Engineer such that the strength of this cement at the time of removal of forms match with strength of portland cement at the time of removal of form as mentioned above. This has to be upported by regular tests.

3.20.6 Tolerance

The formwork shall be so made as to produce a finished concrete, true to shape, lines, levels, plumb and dimensions as shown on the drawings subject to the following tolerances unless otherwise specified in this Specification or drawings or directed by the Engineer:

For

(a)	Sectional dimension	:	+ 5 mm
(b)	Plumb	:	1 in 1000 of height
(c)	Levels	:	+ 3 mm before any deflection has taken place

The tolerance given above are specified for local aberrations in the finished concrete surface and should not be taken as tolerances for the entire structure taken as a whole or for the setting and alignment of formwork, which should be as accurate as possible to the entire satisfaction of the Engineer. Any error, within the above tolerance limits or any other as may be specially set up by the Engineer, if noticed in any lift of the structure after stripping of forms, shall be corrected in the subsequent work to bring back the surface of the structure to its true alignment.

3.20.7 Re-use of Forms

Before re-use, all forms shall be thoroughly scraped, cleaned, joints and planes examined and when necessary repaired, and inside surface treated as

specified hereinbefore. Formwork shall not be used/re- used if declared unfit or unserviceable by the Engineer.

3.20.8 Classification

Generally, the 'ordinary' class formwork shall be used unless otherwise directed by the Engineer:

(a) Ordinary :

These shall be used in places where ordinary surface finish is required and shall be composed of steel and/or approved good quality partially seasoned timber.

(b) Plywood :

These shall be used in exposed surfaces, where a specially good finish is required and shall be made of approved brandof heavy quality plywood to produce a perfectly uniform and smooth surface conforming to the shape described in the drawing with required grain texture on the concrete. Re-use may only be permitted after special inspection and approval by the Engineer. He may also permit utilisation of used plywood for the 'ordinary' class, if it is still in good condition.

(c) Ornamental:

These shall be used where ornamental and curved surface are required and shall be made of selected best quality well seasoned timbers or of plywood, which can be shaped correctly.

3.21 OPENING, CHASES, GROOVES, REBATES, BLOCKOUTS ETC.

The Contractor shall leave all openings, grooves, chases, etc. in concrete work as shown on the drawings or as specified by the Engineer.

3.22 Anchor Bolts, Anchors, Sleeves, Inserts, Hangers/Conduits/Pipe and Other misc. Embedded Fixtures. The Contractor shall build into concrete work all the items noted below and shall embed them partly or fully as directed and

secure the same as may be required. The materials, if required to be supplied by the Contractor, shall be as specified and be of best quality available according to relevant Indian Standards of approved manufacture and to the satisfaction of the Engineer. Exposed surfaces of embedded materials are to be painted with one coat of approved anti-corrosive paint and/or bituminous paint. If welding is to be done subsequently on the exposed surface of embedded material the paint shall be cleaned off the member to a minimum length of 50 mm beyond each side of the weld line.

Necessary templates, jigs, fixtures, supports etc. shall be used as may be required or directed by the Engineer. Items to be embedded.

(a) Inserts, hangers, anchors, frames around openings, manhole covers, frames, floor clips, sleeves conduits and pipes.

(b) Anchor bolts and plates for machinery, equipment and for structural steel work.

(c) Steel structural to be left embedded for future extension, special connection etc.

(d) Lugs or plugs for door and window frames occurring in concrete work.

(e) Flashing and jointing in concrete work.

(f) Any misc. embedment and fixture as may be required.

Correct location and alignment, as per drawings/instruction of all these embedded items shall be entirely the responsibility of the Contractor.

3.23 EXPANSION AND ISOLATION JOINTS

3.23.1 General

Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining

structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval of the method of forming the joints should be obtained from the Engineer before starting the work.

3.23.2 Bitumen Board/Expanded Polystyrene Board

(a) Bitumen Board

Bitumen impregnated fibre board of approved manufacturer as per IS: 1838 may be used as fillers for expansion joints. It must be durable and waterproof. It shall be compressible and possess a high degree of rebound. The dimensions of the board should be equal to that of the joint being formed. It should, preferably be manufactured in one piece, matching the dimension of the joint and not prepared by cutting to size smaller pieces from larger boards at site. At the exposed end, the joint shall be sealed with approved sealing compound to a depth of at least 25 mm after application of an approved primer. The sealing compound and the primer shall be applied as specified by the manufacturer.

(b) Expanded Polystyrene Boards

If required, commercial quality\of expanded polystyrene products commonly used for thermal insulations may also be used as filler material in expansion joints. The thickness may vary from 12 mm to 50 mm. The material will have to be procured from reliable manufacturers as approved by the Engineer. The method of installations will be similar to that recommended by the manufacturers for fixing on cold storage walls. A coat of Bitumen paint may have to be applied on the board against which concrete will be placed.

3.23.3 Joint Sealing Strips

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/ or to exclude passage of water or any other material into or out of the structure.

The sealing strips will be non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The material is to be procured from reputed manufacturers having proven records of satisfactory supply of joint strips of similar make and shape for other jobs. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. The Contractor is to supply all labour and material for installation including the material and tools required for jointing, testing, protection, etc. If desired by the Engineer, joints in rubber seals may have to be vulcanised.

Non - metallic sealing strips will be normally in Rubber or P.V.C. Rubber or P.V.C. joint seals can be of shape having any combination of the following features :

(a) Plain

(b) Central bulb

(c) Dumb-bell or flattened ends

(d) Ribbed and Corrugated Wings

(e) V shaped

As these types of seals can be easily handled in very large lengths, transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer.

The method of forming these joints, laps etc. shall be as specified by the Manufacturer and/or as approved by the Engineer taking particular care to match the central bulbs and the edges accurately.

3.23.3.1 Rubber Sealing Strips

The minimum thickness of Rubber sealing strips shall be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings of items and/ or as directed by the Engineer. The material will be natural rubber and be resistant to corrosion, abrasion and tear and also to attacks from the acids, alkalis and chemicals normally encountered in service. The physical properties will be generally as follows. The actual requirements may be slightly different as decided by the Engineer:

(a)	Specific Gravity	:	1.1 to 1.15
(b)	Shore Hardness	:	65A to 75A
(c)	Tensile Strength	:	25 - 30 N/Sq.mm
(d)	Maximum Safe Continuous Temperature	:	75 Deg.C
(e)	Ultimate Elongation	:	Not less than 350%

3.23.3.2 P.V.C. Sealing Strips

The minimum thickness of P.V.C. sealing strips will be 3 mm and the minimum width 100 mm. The actual size and shape will be as shown in drawings/schedule of items and/or as directed by the Engineer. The material should be of good quality Polyvinyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows. The actual requirements, which will be directed by the Engineer, may vary slightly:

(a)	Specific Gravity	:	1.3 to 1.35
(b)	Shore Hardness	:	60A to 80A
(c)	Tensile Strength	:	10 - 15 N/Sq.mm
(d)	Maximum Safe Continuous Temperature	:	70 Deg.C
(e)	Ultimate Elongation	:	Not less than 275%

3.23.4 Joint Sealing Compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound lay as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834.

Alternatively, when directed, the expansion Joints may be filled with joint sealing compound like "Sikalastic" or approved equivalent and shall be applied as per manufacturer's specification.

3.23.5 Isolation Joints

Strong and tough alkathene or PVC sheet about 1 mm in thickness and as approved by the Engineer shall be used in isolation joints. It shall be fixed by an approved adhesive compound on the cleaned surface of the already set concrete, to cover it fully. Fresh concrete shall be laid against the sheet, care being taken not to damage the sheet in any way.

3.23.6 Rubber Pad

Hard foundation quality rubber pads of required thickness and shapes shall be put below machine or other foundations as shown on the drawings or as directed by the Engineer. The rubber shall have a unit weight of 1500 Kg/Cu.m, a shore hardness-65A to 70A and be of best quality of approved manufacture, durable, capable of absorbing vibration and must be chemically inert in contact with moist or dry earth or any other deleterious material expected under normal conditions.

3.24 GROUTING UNDER MACHINERY OR STRUCTURAL STEEL BASES

If required, grouting under base plates of machines or structural steel etc. shall be carried out by the Contractor. In general, the mix shall be 1 (one) part cement and 1 (one) part sand and just enough water to make it flow as required. The areas to be grouted shall be cleaned thoroughly with compressed air jet and/or with water in locations where accumulated surplus water can be removed. Where directed by the Engineer, 6 mm down stonechips may have to be used in the mix. Surface to be grouted shall be kept moist for at least 24 hours in advance. The grout shall be placed under expert supervision, so that there is no locked up air. Edges shall be finished properly. If desired by the Engineer, admixtures like Aluminium powder; 'Ironite' etc. may have to be added with the grout in proportions to be decided by the Engineer. Admixture, if directed to be added, will be measured and paid separately.

Alternatively non-shink , free flow, cementious grout like "Sikagrout 214/ Ankor NSG" or approved equivalent specifically selected for the type of equipment to be located (vibrating, static etc.) may also be used for grouting as per manufacturer's specification with necessary approval of the Engineer.

3.25 PRECAST CONCRETE

The Specification for precast concrete will be similar as for the cast-in-place concrete described herein and as supplemented in this section. All precast work shall be carried out in a yard made for the purpose.

This yard shall be dry, properly levelled and having a hard and even as well as well drained surface to prevent excessive uneven settlement due to softening of soil during casting & curing. If the ground is to be used as a soffit former of the units, it shall be paved with concrete or masonry and provided with a layer of plaster (1:2 proportion) with smooth neat cement finish or a layer of M.S. sheeting. Where directed by the Engineer, casting will have to be done on suitable vibrating table. The yard, lifting equipment, curing tank, finished material storage space etc. Shall be designed such that the units are not lifted from the mould before 10 (Ten) days of curing and can be removed for erection after 28 (twenty eight) days

of curing. The moulds shall preferably be of steel or of timber lined with G.I. sheet metal and must be rigid enough to prevent distortion during placing and compaction of the concrete.

Other than normal curing by applying water through spray nozzles or perforated hose curing by high pressure steam, steam vapour or other accepted processes may also be employed to accelerate the hardening of the concrete and to reduce the curing time.

Lifting hooks, where necessary or as directed by the Engineer, shall be embedded in correct position of the units to facilitate erection, even though they may not be shown on the drawings, and shall be burnt off and finished after erection.

All members shall be indelibly marked with a unique identification mark on a surface which will not be permanently exposed to show on which production line they were manufactured, their type, the class of concrete, the data of casting and if they are of a symmetrical section the face which will be uppermost when the member is in its correct position after erection.

Precast concrete units, when ready, shall be transported to site by suitable means approved by the Engineer. Care shall be taken to ensure that no damage occurs during transportation. All adjustments, levelling and plumbing shall be done as per instructions of the Engineer. The Contractor shall render all help with instruments, materials and men to the Engineer for checking the proper erection of the precast units.

After erection and alignment, the joints shall be filled with grout or concrete as directed by the Engineer. If centerings have to be used for supporting the precast units, they shall not be removed until the joints have attained sufficient strength and in no case before 14 (fourteen) days. The joint between precast roof planks shall be pointed with 1:2 cement: sand mortar where called for in the drawings.

3.26 WATERPROOFING OF CONCRETE STRUCTURE

3.26.1 General

Waterproofing of concrete structures shall be done by either suitable

extraneous treatment like applying waterproofing paints like "Sikatop Seal" fixing bitumen felts etc. or internally by suitable design of the concrete mix, addition of suitable admixtures conforming to IS: 2645 and equivalent American or British codes in the concrete or mortar at the time of mixing and/or installing water bars at the joints.

The design, material and workmanship shall conform to the relevant I.S. Codes where applicable. The Engineer's approval of the materials shall be obtained by the Contractor before procurement. If desired by the Engineer, test certificates for the materials and samples shall be submitted by the Contractor. The materials shall be of best quality available indigenously, fresh clean and suitable for the duties called upon.

3.26.2 Water Bar/Seal/Special Treatment of Construction Joint

Water bearing structures and underground structures may have water bar/seals installed at the joints. They may be rubber or P.V.C. The materials and installation will be as described under Clause 3.23.3. Construction joint should be provided as per clause 3.13.1 with or without water bar/Seal as shown on the drawing. In case of water bars being used at the construction Joint, fixing of the same has to be done carefully so that the water bar is not disturbed during concreting. The construction joint shall also be treated by any one of the following methods:

(a) Method 1

A surface retarder in the form of a thixotropic gel shall be applied on the joint surface of the previous pour in case of joint on the wall and in case of floor the same shall be applied on the formwork against which previous pour of concreting shall be done. The retarder may be liquid or paste form depending on the type of formwork. The formwork shall be removed within 24 hours after concreting. Within 2 hours of striking of the formwork the retarder shall be washed off with strong water jet to make surface rough and clean. Then a rich cement mortar using cement, sand and aggregates (maximum size 8 mm) along with synthetic rubber emulsion type water resistant bonding agent shall be applied for a depth of 50 mm just before pouring the next stage of concreting in case of walls. The above bonding agent will be mixed with water which will be used for

making the cement mortar. The proportion of mixing of this bonding agent with water shall be as per manufacturer's specification. In case of floor joint, however, after washing of retarder a solvent free two component epoxy resin bonding agent will be used at the joint before the next pour of concrete. The above bonding agent shall have the following properties after 28 days:

(i)	Compressive strength	:	55 to 60 N /Sq. mm
(ii)	Flexural Strength	:	25 to 30 N /Sq. mm.
(iii)	Tensile strength	:	15 N Sq. mm (approx)
(iv)	Bonding strength to concrete	:	3 N / Sq. mm (approx)
(v)	Bonding strength to steel	:	20 N / Sq. mm (approx)

The whole operation shall be done as per manufacturer's specification. The contractor shall provide manufacturer's supervision.

(b) Method 2

One row of threaded nozzles at regular intervals not exceeding 1.5 m centre to centre shall be placed in concrete along the construction joint during casting. Injection of cement water together with a suitable waterproof expanding grouting admixture of approved quality shall be done through the nozzles after the construction joint in walls and slabs. The injection shall be done under pressure of approximately 2 to 4 Kg/Sq cm.

The nozzles shall be sealed off with suitable admixture after the injection is over. The whole operation shall be carried out as per manufacturer's specification and supervision.

3.26.3 Waterproofing Admixtures

The waterproofing admixture for concrete and cement mortar / plaster shall conform to relevant IS code. The admixture shall not cause decrease of

strength of concrete / plaster at any stage and it is free from chlorides and sulphates. The admixture shall not affect the setting time by more than 5 %

The maximum permissible dosage of admixture will be 3% (three percent) by weight of cement but a lower dosage will always be preferred.

The product shall be stored in strong moisture proof packing.

However, in case of important structures where M25 or higher grade concrete is specified, the use of melamine based, high range water resistant concrete admixture shall be used to provide a waterproof concrete around 410 Kg/ Cm.m a melamine based super plasiticizer will be preferable.

(a) In concrete :

The approved admixture shall be based on modified lignosulphonate like "Plastocrete - N/Super" or approved equivalent. The method of application and other details shall conform to the manufacturer's specification and/or as instructed by the Engineer. The Contractor shall have the services of the manufacturer's supervisor to supervise the work, if desired by the Engineer.

(b) In Plaster :

The concrete surface, to be plastered, shall be hacked to Engineer's satisfaction, cleaned thoroughly and kept wetted for 24 hours. The plaster shall be in cement sand mortar mixed in proportion varying from 1:1 to 1:4 by volume along with the approved waterproofing admixture like "Noleak CP/Sika Latex" or approved equivalent and laid in appropriate thickness and in layers not exceeding 15 mm/layer or as per manufacturer's specification. The additive shall be of quality and type approved by the Engineer. If desired by the Engineer, the Contractor shall have the work supervised by the manufacturer's supervisor. On completion, the plastered surface shall be cured continuously for a minimum period of 14 days like concrete.

3.26.4 Bituminous or Tar Coating on External Surface

The surface to be waterproofed shall be rendered absolutely dry, clean and dust free. The surface shall be sand papered, cleaned and completely coated with hot coal tar pitch of approved manufacturer and quality as per IS:216 (not heated above 375 Deg.F) using not less than 2 Kg. per Sq.M. or with hot asphalt i.e., bitumen according to IS:73 (not heated above 400 Deg.F) using not less than 1.5 kg. per Sq.M. When the first coat has completely dried up and approved by the Engineer, the second coat shall be applied in the same manner using not less than 1.25 Kg. per Sq.M. in case of coal tar and 1 Kg. per Sq.M. in case of asphalt. Immediately after application of the second coat and before it is dried up, sand shall be spread on the surface to cover it completely. Sufficient time shall be allowed after spreading of sand before backfilling is done in order to allow the final coat to dry up completely. In place of hot application by coal tar/asphalt the coating of the outside surfaces of walls may be carried out using a ready to use liquid, bituminous emulsion/rubber protective coating of approved manufacturer.

3.26.5 Protective Coating on Inside Surface

Two coats or cement based to components polymer modified flexible protective and waterproofing slurry having 1 mm thick for each coat shall be applied on the walls/floor after proper surface preparation as mentioned above. The slurry shall be applied by brush.

3.26.6 Bitumen Felt : Application for Tanking

This specification shall cover laying the waterproof course on the outside and inside of the walls and bases of structures.

The materials shall conform to IS: 1322, and the workmanship to IS: 1609. The bitumen felt shall be hessian base and/or fibre base as specified in Drawing/Schedule of Items. If required by the Engineer, tests as specified in relevant IS Codes shall be arranged by the Contractor.

The Contractor shall execute this work in direct collaboration with one of the well known specialised approved by the Engineer.

Cleaning the surface, keeping it dry, providing necessary corner fillets and cement rendering and cutting chases, etc. shall be included in the rate for this item. If any protective brickwork on/against concrete sub-bases or walls are required, these will be paid extra under suitable items in the contract. A 20 (twenty) years' guarantee for satisfactory performances shall be given by the Contractor as well as his specialist sub-contractor jointly and severally, for this item of work. Free rectification of any defects noted in the work within this guarantee period will be carried out by the Contractor even if it is beyond the specified maintenance period of the contract as a whole.

3.26.7 Polyethylene Films : Application in Walls or base of Structures

Waterproof treatment shall be applied as outlined and as per sequence given hereunder:

(a) the concrete surface shall be made smooth with 12 mm cement plaster 1:6

(b) apply hot bitumen 80/100 grade (IS:73-1961) at the rate of 1.0 Kg/Sq.m minimum

(c) lay black polyethelene film 250 micron (IS:2508-1977) with cut back bitumen adhesive in overlaps over hot bitumen surface, gently pressed, taking care not to puncture the film.

Alternatively, the overlaps shall be heat sealed by an electric iron having three parallel sealing bars. A long piece of plywood is to be placed below the polyethelene film to be heat sealed. On the plywood a rubber gasket is to be laid to provide a cushion for better welding of the film. On the rubber padding, a celophane tape is to be spread and on this the LDPE film, with 100 mm overlap, is to be stretched. On the overlapped film another celophane tape is to be placed to prevent the heat sealer from sticking to the LDPE film. After this, the electric iron is to be pressed on the overlap joint for sufficient time so as to allow perfect welding. The operation is to be repeated for subsequent lengths of joints. After heat sealing, the celophane tape is to be removed and the joints are to be tested for leaks.

(d) Lay 100 gm brown craft paper laminated with a layer of straight run bitumen.

(e) Lay hot bitument 80/100 grade (IS: 73-1961) at 1.0 Kg/Sq.m minimum.

(f) Lay 250 micron polyethelene film as second layer similar to (c) above.

(g) Lay second layer of 100 gm. brown craft paper laminated similar to (d) above.

(h) Apply hot bitumen (straight run grade) to IS: 73-1961 at 1.0 Kg/Sq.m dusted with fine sand.

(i) Protecting with a layer of 75 mm plain cement concrete M-100 or a layer of brick lay in cement mortar 1:6. In case of wall apply a 12 mm thick plaster as shown on the drawing or a protective brick wall in 1:6 cement mortars as shown on the drawing.

3.27 PROTECTIVE COATING ON CONCRETE SURFACE

3.27.1 On Foundation

The outside faces of foundation of important structures will be protected from adverse effect of soil/underground water, if shown on drawing or instructed by the Engineer, by using bitumen emulsion protective coating of approved manufacturer.

3.28 WATERPROOFING BY PRESSURE /CHEMICAL GROUTING

Where required, waterproofing for underground concrete structure shall be done by injecting high polymer based non-shrink waterproof grouting compound through nozzle under pressure as per manufacturer's recommendation. The pressure during injection shall not be less than 2.5 kg/Sq.cum and the thickness of epoxy resinous emulsion waterproof paint (to be applied on the external surface of walls/slabs) shall not be less than 700 microns.

4.0 SAMPLING AND TESTING

4.1 GENERAL

The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost unless otherwise specified in this specification. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.2 CEMENT

Representative samples will be taken from each consignment of cement received from the manufacturer/supplier for carrying out the tests for fineness (by hand sieving), setting time and compressive strengths. Soundness Tests may also be required to be carried out if required by the Engineer. The tests shall be carried out free of charge by the Owner if cement is supplied by him. In case the Contractor is directed to arrange for the supply of cement as per the terms and conditions of the Contract the tests shall be carried out by him. In case due to any circumstances, the agency of supply is changed in the middle of the Contract, the party who bore the original contractual obligation will carry on with the test, free of charge to the other, till the end of the job. No cement from a particular consignment/batch will be used on the works unless satisfactory 3 (three) days and 7 (seven) days test results for compressive strength are known. The Owner, Engineer and Contractor will jointly associate themselves with the tests irrespective of whether they are carried out by the Owner or the Contractor. These tests are of great importance as their results will have a bearing on the acceptance of concrete or otherwise as per the terms and conditions of the Contract.

4.3 AGGREGATES

The Contractor shall carry out any or all the tests aggregates as may be required by the Engineer in accordance with IS: 2386 PARTS-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant Indian Standards.

4.4 WATER

Sampling and Testing of water being used for concrete works as per IS: 3550 will be carried out by the Contractor at regular intervals and whenever directed by the Engineer. The final acceptance criteria in case of doubt will be as per IS: 3025 & IS: 456.

4.5 ADMIXTURE

4.5.1 Air Entraining Agents (A.E.A)

Initially, before starting to use A.E.A., relationship between the percentage of air entrained and the cube crushing strength vis-a-vis quantity of A.E.A. used for all types of concrete will be established by the Contractor by carrying out sufficiently large number of tests. After then, at regular intervals and whenever directed by the Engineer, the Contractor will check up the actual percentages of air entrained and corresponding crushing strengths to correlate with the earlier test results.

4.5.2 Other Admixtures

Tests for establishing the various properties of any other admixtures which may be required to be added shall be carried out by the Contractor.

4.6 CONCRETE

The sampling of concrete, making the test specimens, curing and testing procedure etc. shall be in accordance with IS: 516 and IS: 1199 the size of specimen being 15 cm cubes. Normally, only compression tests shall be performed but under special circumstances the Engineer may require other tests to be performed in accordance with IS: 516.

Sampling procedure, frequency of sampling and test specimen shall conform to Clause 14 of IS: 456.

To control the consistency of concrete from every mixing plant, slump tests and/or compacting factor tests in accordance with IS: 1199 and as mentioned in Clause 3.6 of this Specification shall be carried out by the

Contractor every two hours or as directed by the Engineer. Slumps corresponding to the test specimens shall be recorded for reference.

The acceptance criteria of concrete shall be in accordance with Clause 15 of IS: 456.

Concrete work found unsuitable for acceptance shall have to be dismantled and replacement is to be done as per specification by the Contractor. No payment for the dismantled concrete, the relevant formwork and reinforcement, embedded fixtures, etc. wasted in the dismantled portion shall be made. In the course of dismantling, if any damage is done to the embedded items or adjacent structures, the same shall be made good to the satisfaction of the Engineer.

5.0 ACCEPTANCE CRITERIA

5.1 STANDARD DEVIATION

Standard deviation shall be based on test results and determination of Standard deviation shall conform to clause 16 of IS: 456.

5.2 ACCEPTANCE CRITERIA

The strength requirements and acceptance criteria shall conform to Clause 16 of IS: 456.

5.3 INSPECTION AND CORE TESTS

Inspection of concrete work immediately after stripping the formwork and core test of structures shall conform to Clause 17 of IS: 456.

5.4 LOAD TEST

Load tests of structural members may be required by the Engineer, when the strength of test specimen results falls below the required strength, as per Load Test on Parts of Structures', Clause 17.6 of IS: 456. If load testing is decided by the Engineer, the member under consideration shall be subjected to a test load equal to 1.25 (one and a quarter) times the specified live load used for design and this load shall be maintained for a period of

24 (twenty four) hours before removal. The detailed procedure of the test is to be decided by the Engineer. Load tests shall not be made until the structure is at least 56 days old.

If the member shows evident failure, such changes as are necessary to make the structure adequately strong shall be made by the Contractor. Alternatively, if permitted under Statutory Regulations and at the discretion of the Engineer, the structure under test or a portion thereof may be retained as such without any modification by de-rating its load bearing capacity, provided the design criteria allows such de-rating.

A reinforced concrete beam, floor or roof shall be deemed to have passed the test if the maximum deflection at the end of 24 hours does not exceed the deflection given in Clause 17.6 of IS: 456.

The entire cost of load testing shall be borne by the Contractor. If a portion of the structure is found to be unacceptable, it shall be dismantled and replaced by a new structure as per specification.

If, in the course of dismantling, any damage is done to the embedded items and or other adjacent structures, the same will be made good by the Contractor to the satisfaction of the Engineer.

6.0 LIST OF I.S. CODES AND STANDARDS FOR REFERENCE

All work under this specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other India Standard Specifications and Codes of Practice. In case any particular aspect of work is not specifically covered by Indian Standard Specifications, any other standard practice, as may be specified by the Engineer, shall be followed :-

(a)	IS : 73	:	Indian Standard Specification for Paving Bitumen
(b)	IS : 216	:	Indian Standard Specification for Coal Tar Pitch
(c)	IS : 269	:	Indian Standard Specification for 33 grade Ordinary Portland Cement

(d)	IS : 383	:	Indian Standard Specification for Coarse and Fine Aggregates from Natural Sources for Concrete
(e)	IS : 432	:	Indian Standard Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for concrete Reinforcement - Part 1 & 2
(f)	IS : 455	:	Indian Standard Specification for Portland Slag Cement
(g)	IS : 456	:	Indian Standard Code of Practice for Plain and Reinforced Concrete
(h)	IS : 457	:	Indian Standard Code of Practice for General Construction of Plain and Reinforced Concrete for Dams and other Massive Structures
(i)	IS : 516	:	Indian Standard Specification for Methods of Test for Strength of Concrete
(j)	IS : 737	:	Indian standard specification for wrought Aluminium and Aluminium Alloy sheet and strip for general Engineering purpose.
(k)	IS : 1199	:	Indian Standard Specification for Methods of Sampling and Analysis of Concrete
(l)	IS : 1200	:	Indian Standard Specification for Method of (Part-II) Measurement Cement Concrete Works.
(m)	IS : 1200	:	Indian Standard Specification for Method of (Part-V) Measurement of Formwork
(n)	IS : 1322	:	Indian Standard Specification for Bitumen Felts for waterproofing and Damp-proofing
(o)	IS : 1489	:	Indian Standard Specification for Portland–Pozzolona Cement-Part 1 & 2
(p)	IS : 1566	:	Indian Standard Specification for hard drawn steel wire fabric for concrete reinforcement.
(q)	IS : 1609	:	Code of Practice for Laying Damp-proof Treatment using Bitumen Felts

(r)	IS : 1786	:	Indian Standard Specification for high strength deformed Bars & wires for Concrete Reinforcement
(s)	IS : 1791	:	Indian Standard Specification for Batch Type Concrete Mixers
(t)	IS : 1834	:	Indian standard specification for hot applied sealing compound for joint in concrete.
(u)	IS : 2062	:	Steel for general structural purpose.
(v)	IS : 2185	:	Indian Standard Specification for Hollow and solid / solid light wt. Cement Concrete Blocks - Part - 1 & 2
(w)	IS : 2210	:	Indian Standard Specification for Design of Reinforced Concrete Shell Structures and Folded Plates
(x)	IS : 2386	:	Indian Standard Specification for Methods of Test for Aggregates for Concrete - Part-I to VIII
(y)	IS : 2430	:	Indian standard specification for method of sampling of Aggregate for concrete.
(z)	IS : 2502	:	Indian Standard Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement
(aa)	IS : 2505	:	Indian Standard Specification for Concrete Vibrators Immersion Type
(bb)	IS : 2506	:	Indian Standard Specification for Screed Board Concrete Vibrators
(cc)	IS : 2514	:	Indian Standard Specification for Concrete Vibrating Tables
(dd)	IS : 2645	:	Integral Cement water proofing compound
(ee)	IS : 2722	:	Indian Standard Specification for Portable Swing Weigh Batchers for Concrete (Single and Double Bucket type)
(ff)	IS : 2751	:	Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete Construction

(gg)	IS : 2770	:	Indian Standard Specification for Method of Testing Bond in Reinforced Concrete. Part - 1 : Pull out Test
(hh)	IS : 3025	:	Indian Standard Specification for Methods of Sampling and Test (Physical and Chemical) for Water & waste water - art - 1 to 37
(ii)	IS : 3201	:	Indian Standard Specification for Design and Construction of Precast Concrete Trusses and purlins.
(jj)	IS : 3370	:	Indian Standard Specification for Code of Practice for Concrete Structures for Storage of Liquids Part 1 to 4
(kk)	IS : 3384	:	Indian standard specification for / Bitumen primer for use in waterproofing and Danp proofing
(ll)	IS : 3414	:	Code of practice for Design and Installation of joints in Buildings
(mm)	IS : 3550	:	Indian Standard Specification for Method of Test for Routine Control for Water used in Industry
(nn)	IS : 3558	:	Code of Practice for use of Immersion Vibrators for Consolidating Concrete
(oo)	IS : 3696	:	Safety Code for Part-1 : Scaffolding and Part 2: Ladders
(pp)	IS : 3812	:	Indian Standard Specification for Fly Ash for Use as Pozzolone & Admixture
(qq)	IS : 4031	:	Indian Standard Specification for Method of Tests for Hydraulic Cement - Part - 1 to 14
(rr)	IS : 4082	:	Indian Standard Specification for Recommendation on Stacking and Storag of Construction Materials at site
(ss)	IS : 4090	:	Indian Standard Specification for Design of Reinforced Concrete Archs

(tt)	IS : 4634	:	Indian Standard Specification for Method of Testing Performance of Batch-type Concrete Mixers
(uu)	IS : 4656	:	Indian Standard Specification for Form Vibrators for Concrete
(vv)	IS : 4925	:	Indian Standard Specification for Concrete Batching and Mixing Plant
(ww)	IS : 4926	:	Indian Standard Specification for Ready Mixed Concrete
(xx)	IS : 4990	:	Indian Standard Specification for Plywood for Concrete suttering work
(yy)	IS : 4991	:	Indian Standard Specification for Blast Resistant Design of Structure for Explosion above ground
(zz)	IS : 4995	:	Indian Standard Specification for Design (Part-I of Reinforced Concrete Bins for the Storage & II) of Granular and Powdery Materials
(aaa)	IS : 4998	:	Indian Standard Specification for Design of (Part - I) Reinforced Concrete Chimneys
(bbb)	IS : 5512	:	Indian Standard Specification for Flow Table for use in Tests of Hydraulic Cement and Pozzolanic Materials
(ccc)	IS : 5513	:	Indian Standard Specification or Vicat Apparatus
(ddd)	IS : 5515	:	Indian Standard Specification for Compaction Factor Apparatus
(eee)	IS : 5751	:	Indian Standard Specification for Precast Concrete Coping Blocks
(fff)	IS : 5816	:	Indian Standard Specification for Method of Test for Splitting Tensile Strength of Concrete Cylinders
(ggg)	IS : 5891	:	Indian Standard Specification for Hand Operated Concrete Mixers

(hhh)	IS : 6452	:	Indian Standard Specification for High Alumina Cement for Structural Use
(iii)	IS : 6909	:	Indian Standard Specification for Supersulphated Cement
(jjj)	IS : 6923	:	Indian Standard Specification for Method of Test for performance of Screed Board Concrete Vibrators
(kkk)	IS : 6925	:	Indian Standard Specification for Method of Test for Determination of Water Soluble Chloride in Concrete Admixtures
(lll)	IS : 7242	:	Indian Standard Specification for Concrete Spreaders
(mmm)	IS : 7246	:	Indian Standard Specification for Table Vibrators for Consolidating Concrete
(nnn)	IS : 7251	:	Indian Standard Specification for Concrete Finishers
(ooo)	IS : 7320	:	Indian Standard Specification for Concrete Slump Test Apparatus
(ppp)	IS : 7861	:	Indian Standard Specification for (Part-I Recommended Practice for hot and cold & II) Weather Concreting
(qqq)	IS : 7969	:	Safety Code for Storage and Handling of Building Materials
(rrr)	IS : 8041	:	Indian Standard Specification for Rapid Hardening Portland cement
(sss)	IS : 8043	:	Indian standard specification for hydrophobic cement
(ttt)	IS : 8112	:	Indian Standard Specification for 43 grade Ordinary Portland Cement
(uuu)	IS : 8142	:	Indian Standard Specification for Determining Setting time of Concrete by Penetration Resistance

(vvv)	IS : 8989	:	Safety Code for Erection of Concrete Framed Structures
(www)	IS : 9013	:	Indian Standard Specification for Method of Making, Curing and Determining Compressive Strength of Accelerated - cured Concrete Test Specimens
(xxx)	IS : 9077	:	Code of Practice for Corrosion Protection of Steel Rails in RB and RCC Construction
(yyy)	IS : 9103	:	Indian Standard Specification for Admixtures for Concrete.
(zzz)	IS : 9417	:	Recommendation for welding cold worked bars for reinforced concrete construction
(aaaa)	IS : 10262	:	Recommended Guideline for concrete Mix Design
(bbbb)	IS : 12269	:	Indian standard specification for 53 grade ordinary Portland cement
(cccc)	IS : 12330	:	Indian standard specification for sulplateresting Portland cement
(dddd)	IS : 12600	:	Indian standard specification for low heat Portland cement

VOLUME VI-B

SECTION – 4

FABRICATION OF STRUCTURAL STEEL WORK

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	GENERAL
3.0	WORKMANSHIP
4.0	INSPECTION, TESTING, ACCEPTANCE, CRITERIA AND DELIVERY
5.0	INFORMATION TO BE SUBMITTED

1.0 SCOPE

This specification covers supply of all raw steel materials, fabrication, testing, painting and delivery to site of structural steelwork including supply of all consumable stores and bolts, nuts, washers, electrodes and other materials required for fabrication and field connections of all structural steelwork in general covered under the scope of the contract. However, for any special structures such as rail & road bridges, steel chimney, tanks, transmission towers, furnace structures, etc., the relevant Indian Standard or IRC specification and Codes of Practices shall be given due consideration over & above this specification.

2.0 GENERAL

2.1 WORK TO BE PROVIDED FOR BY THE CONTRACTOR

The work to be provided for by the bidder unless otherwise specified elsewhere in the contract, shall include, but not be limited to the following:

2.1.1 Preparation of complete detailed fabrication drawings and erection marking drawings required for all the structures covered under the scope of the contract based on contractor's design drawings approved by the Owner / Consultants.

2.1.2 To submit revised design with calculations and detailed fabrication drawings in case any substitution of the designed sections are to be made.

2.1.3 To submit design calculations for joints and connections developed by the contractor along with detailed fabrication drawings

2.1.4 Furnish all materials, labour, tools and plant and all consumables required for fabrication and supply, all necessary bolts, nuts, washers, tie rods and welding electrodes for field connections. The field connection materials supplied by the contractor shall be in adequate quantity to avoid delay in erection.

2.1.5 Furnish shop painting of all fabricated steelwork as per requirements of this Specification.

2.1.6 Suitably mark, bundle and pack for transport all fabricated materials.

2.1.7 Prepare and furnish detailed Bill of Materials, Drawing Office Despatch lists, Bolt List and any other list of bought out items required in connection with the fabrication and erection of the structural steelwork.

2.1.8 Insure, load and transport all fabricated steelwork field connection materials to site.

2.2 WORK BY OTHERS

No work under this specification will be provided for by any agency other than the bidder, unless specifically mentioned otherwise elsewhere in the contract.

2.3 CODES AND STANDARDS

All work under this specification shall, unless otherwise specified in the contract, conform to the requirements of the latest revision and/or replacements of the following or any other relevant Indian Standard specifications and codes of practice. In case any particular aspect of the work is not specifically covered by any Indian Standard Specification, any other standard practice, as may be specified by the Engineer shall be followed:

2.3.1 Relevant To Fabrication Of Structural Steel Work

(a) IS : 800 : Code of practice for general construction in steel.

(b) IS : 801 : Code of practice for use of cold formed light gauge steel structural members in general building Construction

(c) IS : 806 : Code of practice for use of steel tubes in general building construction.

(d)	IS : 808	:	Dimensions for rolled steel beams, channels and angle Sections
(e)	IS : 812	:	Glossary of terms relating to welding & cutting of Metals
(f)	IS : 813	:	Scheme of symbols for welding
(g)	IS : 814	:	Covered electrodes for metal arc welding of carbon and carbon manganese steel
(h)	IS : 815	:	Classification coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel.
(i)	IS : 816	:	Code of practice for use of metal arc welding for general construction in mild steel
(j)	IS : 817	:	Code of practice for training & testing metal arc welders
(k)	IS : 818	:	Code of practice for safety and health requirements in electric and gas welding and cutting operations.
(l)	IS : 819	:	Code of practice for resistance spot welding for light assemblies in mild steel.
(m)	IS : 822	:	Code of practice for inspection of welds.
(n)	IS : 919	:	Recommendations for limits and fits for engineering (part – 1 & 2)
(o)	IS : 1161	:	Steel Tubes for structural purposes
(p)	IS : 1182	:	Recommended practice for Radiographic Examination of fushion welded butt joints in steel plates`
(q)	IS : 1200 (part – 8)	:	Method of measurement of steel work and iron work
(r)	IS : 1239 (Part – 1 & 2)	:	Mild steel tubes, tubulars and other wrought steel

(s)	IS : 1363 (Part - 1 to 3)	:	Hexagon head bolts, screws and nuts of product grade C
(t)	IS : 1364 (Part – 1 to 5)	:	Hexagon head bolts, screws and nuts of product grade A & B
(u)	IS : 1365	:	Slotted counter sunk head screws (dia. 1.6 to 20 mm)
(v)	IS : 1367 (part – 1 to 18)	:	Technical supply conditions for threaded steel fasteners
(w)	IS : 1608	:	Method for tensile testing of steel products.
(x)	IS : 1730	:	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
(y)	IS : 1852	:	Rolling and cutting tolerances for hot-rolled steel product.
(z)	IS : 1977	:	Structural steel (Ordinary quality)
(aa)	IS : 2016	:	Plain washer
(bb)	IS : 2062	:	Steel for general structural purposes.
(cc)	IS : 2629	:	Recommended practice for hot-dip galvanising of iron and steel
(dd)	IS : 2633	:	Method for testing uniformity of coating on zinc coated articles
(ee)	IS : 3644	:	Code of practice for ultrasonic pulse echo testing by contact and immersion method
(ff)	IS : 3757	:	High Strength Structural Bolt
(gg)	IS : 4000	:	High strength bolts in steel structure
(hh)	IS : 4759	:	Specifications for hot-dip zinc coatings on structural steel and other allied products.
(ii)	IS : 4923	:	Hollow steel sections for structural use

(jj)	IS : 5334	:	Code of practice for magnetic particle flaw detection of weld.
(kk)	IS : 5369	:	General requirements for plain washers and lock washer.
(ll)	IS : 6005	:	Code of practice for phosphating of iron and steel.
(mm)	IS : 6649	:	Specification for hardened and tempered washers for high strength structural bolts and nuts.
(nn)	IS : 6623	:	Specification for high strength structural nuts.
(oo)	IS : 7215	:	Tolerances for fabrication of steel structures.
(pp)	IS : 7280	:	Bare wire electrode for submerged arc welding.
(qq)	IS : 8500	:	Structural steel micro alloyed (medium & high strength quality).
(rr)	IS : 8629	:	Code of practice for protection of iron and (Part - I to III) steel structures from atmospheric corrosion.
(ss)	IS : 9595	:	Recommendation for metal arc welding of carbon manganese steels.

2.3.2 Painting

(a)	IS : 117	:	Specification for ready mixed paint, brushing, finishing, exterior, semi-gloss, for general purposes
(b)	IS : 128	:	Specification for ready mixed paint, brushing, finishing, semi-gloss for general purposes, black
(c)	IS : 1477 (Part - I & II)	:	Code of practice for painting of ferrons metal in building.
(d)	IS : 2074	:	Ready mixed paint, air-drying red-oxide zinc chrome priming.

(e) IS : 2339 : Specification for aluminium paints for general purposes in dual container.

(f) IS : 2932 : Specification for enamel, synthetic exterior type - I.

(g) IS : 2933 : Specification for enamel, synthetic exterior type - II.

2.4 CONFORMITY WITH DESIGNS

The bidder shall design all connections, supply and fabricate all steelwork and furnish all connection materials in accordance with the approved drawings and/or as instructed by the Engineer keeping in view the maximum utilization of the available sizes and sections of steel materials. The methods of painting, marking, packing and delivery of all fabricated materials shall be in accordance with the provisions of the contract and/or as approved by the Engineer. Provision of all relevant Indian Standard Specifications and Codes of Practice shall be followed unless otherwise specified in the contract.

2.5 MATERIALS TO BE USED

2.5.1 General

All steel material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance. All materials shall be tested quality only unless otherwise permitted by the Engineer and/or consultant. If desired by the Engineer, Test Certificates of materials supplied by the contractor in respect of each consignment shall be submitted in triplicate. Whenever the materials are required to be used from unidentifis stocks, if permitted by the Engineer, a random, sample shall be tested at an approval laboratory from each lot of 50 tonnes or less of any particular section.

The arc welding electrodes shall conform to be relevant Indian Standard codes of Practice and Specifications and shall be heavily coated type and the thickness of the coating shall be uniform and concentric. With each container of electrodes, the manufacturer shall furnish instructions giving recommended voltage and ampereage (Polarity in case of D.C. supply) for which the electrodes are suitable.

2.5.2 Steel

All steel materials to be used in construction within the purview of this specification shall comply with anyof the following Indian Standard Specifications as may be applicable :

(a)	IS : 801	:	Cold formed light gauge steel structural member
(b)	IS : 806	:	Steel tubes in general building construction.
(c)	IS : 1161	:	Steel tubes for structural purpose.
(d)	IS : 1977 St-42-0	:	Structural steel (Ordinary quality)
(e)	IS : 2062	:	Steel for general structural purpose
(f)	IS : 8500	:	Structural steel-microalloyed (Ordinary & high strength quality)

In case of imported steel materials being used, these shall conform to specifications equivalent to any of the above as may be applicable.

2.5.3 Electrodes

All electrodes to be used under the Contract shall comply with any of the following Indian Standard Specifications as may be applicable:

(a)	IS : 814	:	Covered electrodes for metal arc welding structural steel
(b)	IS : 815	:	Classification and coding of covered electrodes for metal arc welding of mild steel and low alloy high tensile steel
(c)	IS : 7280	:	Base wire electrode for submerged arc welding

2.5.4 Bolts and Nuts

All bolts and nuts shall conform to the requirements of Indian Standard

Specification IS:1367 - Technical Supply Conditions for Threaded Fasteners Materials for Bolts and nuts under the purview of this contract shall comply with any of the following Indian Standard Specifications as may be applicable

(a) Mild Steel : All mild steel for bolts and nuts when tested in accordance with the following Indian Standard Specification shall have a tensile strength of not less than 44 Kg/mm2 and a minimum elongation of 23 per cent on a gauge length of 5.6 /A, where 'A' is the cross sectional area of the test specimen :

(i) IS:1367 : Technical supply conditions for threaded fasteners

(ii) IS:1608 : Method for tensile testing of steel other than sheet, strip, wire and tube

(b) High Tensile Steel : The material used for the manufacture of high tensile steel bolts and nuts shall have the mechanical properties appropriate to the particular class of steel as set out in IS:1367 or as approved by the Engineer

2.5.5 Washers

Washers shall be made of steel conforming to any of the following Indian Standard Specifications as may be applicable under the provisions of the Contract :

(a) IS : 1977 : Structural steel (Ordinary Quality) St-42-0

(b) IS : 2062 : Steel for general structural purpose

(c) IS : 8500 : Structural steel – microalloyed (medium & high strength quality)

(d) IS : 6623 : High Strength Structural Nuts

(e) IS : 6649 : Hardened and tampered washers for high strength structural bolts & nuts.

2.5.6 Paints

Paints to be used for shop coat of fabricated steel under the purview of this contract shall conform to the Indian Standard Specification IS:2074 - Ready mixed Paint, Air Drying, Red Oxide - Zinc Chromate Priming.

In highly corrosive environment other type of primer such as epoxy resin based zinc rich primer (such as blast steel EZ1 of Shalimer Paints Ltd., may be necessary.

2.6 STORAGE OF MATERIAL

2.6.1 General

All materials shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged shall be removed from the contractor's yard immediately, failing which, the Engineer shall be at liberty to get the material removed. The Contractor shall maintain upto date accounts in respect of receipt, use and balance of all sizes and sections of steel and other materials.

In case the fabrication is carried out in contractor's fabrication shop outside the plant site where other fabrication works are also carried out, all materials meant for use in this contract shall be stacked separately with easily identifiable marks.

2.6.2 Steel

The steel to be used in fabrication and the resulting cut-pieces shall be stored in separate stacks off the ground section-wise and lengthwise so that they can be easily inspected, measured and accounted for at any time. If required by the Engineer, the materials may have to be stored under cover and suitably painted for protection against weather.

2.6.3 Electrodes

The electrodes for electric are welding shall be stored in properly designed racks separating different types of electrodes in distinctly marked

compartments. The electrodes shall be kept in a dry and warm condition if necessary by resorting to heating.

2.6.4 Bolts, Nuts and Washers

Bolts, nuts and washers and other fastening materials shall be stored on racks off the ground with a coating of suitable protective oil. These shall be stored in separate gunny bags or compartments according to diameter, length and quality.

2.6.5 Paints

Paints shall be stored under cover in air tight containers. Paints supplied in sealed containers shall be used up as soon as possible once the container is opened.

2.7 QUALITY CONTROL

The Contractor shall establish and maintain quality control procedures for different items of work and materials to the extent he deems necessary to ensure that all work is performed in accordance with this specification. In addition to the Contractor's quality control procedures, materials and workmanship at all times shall be subjected to inspection by the Engineer or Engineer's representative. As far as possible, all inspection by the Engineer or Engineer's representative shall be made at the Contractor's fabrication shop whether located at Site or elsewhere. The Contractor shall co-operate with the Engineer or Engineer's representative in permitting access for inspection to all places where work is being done and in providing all necessary help in respect of tools and plants, instrument, labour and materials required to carry out the inspection. The inspection shall be so scheduled as to provide the minimum interruption to the work of the Contractor.

Materials or workmanship not in reasonable conformance with the provisions of this Specification may be rejected at any time during the progress of the work.

The quality control procedure shall cover but not be limited to the following items of work:

(a)	Steel	:	Quality, manufacturer's test certificates, test reports of representative samples of materials from unidentified stocks if permitted to be used.
(b)	Bolts, Nuts & Washers	:	Manufacturer's certificate, dimension checks, material testing
(c)	Electrodes	:	Manufacturer's certificated, thickness and quality of flux coating.
(d)	Welders	:	Qualifying Tests
(e)	Welding sets	:	Performance Tests
(f)	Welds	:	Inspection, X-ray, Ultrasonic tests
(g)	Paints	:	Manufacturer's certificate, physical inspection reports
(h)	Galvanizing	:	Test in accordance with IS : 2633 – Method for testing uniformity of coating on Zinc Coated Articles and IS : 4759 – Specification for Hot-Dip Zinc coatings on Structural Stell and other allied products.

2.8 STANDARD DIMENSIONS, FORMS AND WEIGHTS

The dimensions, forms, weights and tolerances of all rolled shapes bolts, nuts, studs, washers etc. and other members used in the fabrication of any structure shall, wherever applicable, conform to the requirements of the latest relevant Indian Standards, wherever they exist, or, in the absence of Indian Standards, to other equivalent standards.

2.9 SHOP DRAWINGS

The Contractor shall submit to the Engineer the Schedule of Fabrication and delivery of structural steelwork for approval. He shall start to submit progressively for approval the shop drawings based on the approved

Design Drawings and before proceeding with the fabrication work, shall get the said shop drawings approved in accordance with the contract.

The sequence of submission of shop drawings for approval shall match with the approved fabrication and delivery schedule. The approval for the shop drawings will be accorded only towards the general conformity with the design requirements as well as specification and will ensure the correctness of general arrangement for centreline dimensions and levels, Section sizes, and adequacy of connections including splice joints as to the no. of bolts, weld length, size of gusset/end plates.

The correctness of all other details like cutting lengths, matching of holes, notch dimensions, match markings, bill of materials, bolt list etc. will be entirely the contractor's responsibility. The approval of the drawing however shall not relieve the contractor of his sole responsibility in carrying out the work correctly and fulfilling the complete requirements of contract documents.

The shop drawings shall include but not be limited to the following:

(a) Assembly drawings giving exact sizes of the sections to be used and identification marks of the various sections.

(b) Dimensional drawings of base plates, foundation bolt location etc.

(c) Details of all connections with supporting calculations.

(d) Comparison sheets to show that the proposed alternative section, if any, are as strong as the original sections shown on the Design Drawings.

(e) Complete Bill of Materials and detailed drawings of all sections as also their billing weights.

(f) Any other drawings or calculations that may be required for the clarification of the works or substituted parts thereof.

The shop drawings shall give all the necessary information for the fabrication, erection and painting of the steelwork in accordance with

the provisions of this Specification. Shop drawings shall be made in accordance with the best modern practice and with due regard to sequence, speed and economy in fabrication and erection. Shop drawings shall give complete information necessary for fabrication of various components of the steelwork, including the location, type, size and extent of welds. These shall also clearly distinguish between shop and field bolts and welds and specify the class of bolts and nuts. The drawings shall be drawn to a scale large enough to convey all the necessary information adequately.

Notes on the shop drawings shall indicate those joints or groups of joints in which it is particularly important that the welding sequence and technique of welding shall be carefully controlled to minimize the locked -up stresses and distortion.

Welding symbols used shall be in accordance with the requirements of the Indian Standard Specification - IS:813 - Scheme of symbols for Welding, and shall be consistent throughout. Weld lengths called for on the drawings shall mean the net effective length.

The Contractor shall be responsible for and shall pay for any alterations of the work due to any discrepancies, errors or omissions on the drawings or other particulars supplied by him, whether such drawings or other particulars have been duly approved or not in accordance with the Contract.

3.0 WORKMANSHIP

3.1 FABRICATION

3.1.1 General

All workmanship shall be equal to the best practice in modern structural shops, and shall conform to the provisions of the Indian Standard IS:800 - Code of Practice for use of Structural Steel in General Building Construction and other relevant Indian Standards.

3.1.2 Straightening Material

Rolled materials before being laid off or worked, must be clean, free from sharp kinks, bends or twists and straight within the tolerances allowed by the Indian Standard Specification IS:1852 - Specification for rolling and cutting tolerance for hot-rolled steel products. If straightening is necessary, it may be done by mechanical means or by the application of a limited amount of localized heat. The temperature of heated areas, as measured by approved methods, shall not exceed 600 Deg. C.

3.1.3 Cutting

Cutting shall be effected by shearing, cropping or sawing. Use of a mechanically controlled gas cutting torch may be permitted for mild steel only. Gas cutting of high tensile steel may also be permitted provided special care is taken to leave sufficient metal to be removed by machining, so that all metal that has been hardened by flame is removed. Gas cutting without a mechanically controlled torch may be permitted if special care is taken and done under expert hand, subject to the approval of the Engineer.

To determine the effective size of members cut by gas, 3 mm shall be deducted from each cut edge. Gas cut edges, which will be subjected to substantial stress or which are to have weld metal deposited on them, shall be reasonably free from gouges. Occasional notches or gauges not more than 4 mm deep will be permitted. Gouges greater than 4mm, that remain from cutting, shall be removed by grinding. All re-entrant corners shall be shaped notch-free to a radius of at least 12 mm. Shearing, cropping and gas cutting shall be clean, reasonably square and free from any distortion.

3.1.4 Planning of edges

Planning or finishing of sheared or cropped edges of plates or shapes or of edges gas-cut with a mechanically controlled torch shall not be required unless specifically required by design and called for on the drawings, included in a stipulation for edge preparation for welding or as may be required after the inspection of the cut surface. Surface cut with hand flame shall generally be ground, unless specifically instructed otherwise by the Engineer.

3.1.5 Clearances

The erection clearance for cleated ends of members connecting steel to steel shall preferably be not greater than 2 mm at each end. The erection clearance at ends of beams without web cleats shall be not more than 3 mm at each end, but where, for practical reasons, greater clearance is necessary, suitably designed cleatings shall be provided.

3.2 BOLTED CONSTRUCTION

3.2.1 Holes

Holes through more than one thickness of material for members, such as compound stanchions and girder flanges, shall be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, if the thickness of the material is not greater than the nominal diameter of bolt plus 3 mm subject to a maximum thickness of 16 mm provided that the holes are punched 3 mm less in diameter than the required size and reamed after assembly to the full diameter.

Holes for rivets or black bolts shall be not more than 1.5 mm or 2.0 mm (depending on whether the diameter of the bolt is less or more than or equal to 25 mm) larger in diameter than the nominal diameter of the black bolt passing through them.

Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to a tolerance grade of H8 as specified in IS: 919. Parts to be connected shall be firmly held together by tacking welds or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled trough all thickness in one operation shall be drilled to a smaller size and reamed out after assembly.

Holes for bolts shall not be formed by gas cutting process.

3.2.2 Assemble

Drifting to enlarge unmatching holes shall not generally be permitted. In case drifting is permitted to a slight extent during assembly, it shall not distort the metal or enlarge the holes. Holes that must be enlarged to admit the bolts shall be reamed. Poor matching of holes shall be cause for rejection. The component parts shall be so assemble that they are neither twisted not otherwise damaged, and shall be so prepared that the specified cambers, if any, are maintained.

Bolted construction shall be permitted only in case of field connections if called for on the Drawings and is subjected to the limitation of particular connections as may be specified. In special cases, however, shop bolt connections may be allowed if directed by the Engineer.

Washers shall be tapered or otherwise suitably shaped, where necessary, to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project out through the nut at least one thread. In all cases the bolt shall be provided with a washer of sufficient thickness under the nut to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. In addition to the normal washer, one spring washer or lock-nut shall be provided for each bolt for connections subjected to vibrating forces or otherwise as may be specified on the Drawings.

3.3 WELDED CONSTRUCTION

3.3.1 General

Welding shall be in accordance with relevant Indian Standards and as supplemented in the Specification. Welding shall be done by experienced and good welders who have been qualified by tests in accordance with IS:817.

3.3.2 Preparation of Material

Surface to be welded shall be free from loose scale, slag, rust, grease, paint and any other foreign material except that mill scale which withstands vigorous wire brushing may remain. Joint surfaces shall be free from fins and tears. Preparation of edges by gas-cutting shall, wherever practicable, be done by a mechanically guided torch.

3.3.3 Assembling

Parts to be fillet welded shall be brought in as close contact as practicable and in no event shall be separated by more than 4 mm. If the separation is 1.5 mm or greater, the size of the fillet weld shall be increased by the amount of the separation. The fit of joints at contact surfaces which are not completely sealed by welds, shall be close enough to exclude water after painting. Abutting parts to be butt-welded shall be carefully aligned. Misalignments greater than 3 mm shall be corrected and in making the correction the parts shall not be drawn into a sharper slope than two degrees (2 Deg.).

The work shall be positioned for flat welding whenever practicable.

3.3.4 Welding Sequence

In assembling and joining parts of a structure or of built-up members, the procedure and sequence of welding shall be such as will avoid needless distortion and minimize shrinkage stresses. Where it is impossible to avoid high residual stresses in the closing welds of a rigid assembly, such closing welds shall be made in compression elements.

In the fabrication of cover-plated beams and built-up members, all shop splices in each component part shall be made before such component part is welded to other parts of the member. Long girders or girder sections may be made by shop splicing not more than three sub-sections, each made in accordance with this paragraph. When required by the Engineer, welded assemblies shall be stress relieved by heat treating in accordance with the provisions of the relevant Indian Standard or any other Standard approved by the Engineer.

3.3.5 Welding technique

All complete penetration groove welds made by manual welding, except when produced with the aid of backing material not more than 8 mm thick with root opening not less than one-half the thickness of the thinner part joined, shall have the root of the initial layer gouged out on the back side before welding is started from that side, and shall be so welded as to secure sound metal and complete fusion throughout the entire cross section. Groove welds made with the use of the backing of the same material as the base metal shall have the weld metal thoroughly fused with the backing material. Backing strips need not be removed. If required, they may be removed by gouging or gas cutting after welding is completed, provided no injury is done to the base metal and weld metal and the weld metal surface is left flush or slightly convex with full throat thickness.

Groove welds shall be terminated at the ends of a joint in a manner that will ensure their soundness. Where possible, this should be done by use of extension bars or run-off plates. Extension bars or run-off plates need not be removed upon completion of the weld unless otherwise specified elsewhere in the Contract.

To get the best and consistent quality of welding, automatic submerged arc process shall be preferred. The technique of welding employed, the appearance and quality of welds made, and the methods of correcting defective work shall all conform to the relevant Indian Standards.

3.3.6 Temperature

No welding shall normally be done on parent material at a temperature below (-) 5 Deg.C. However, if welding is to be undertaken at low temperature adequate precautions as recommended in relevant Indian Standard shall be taken. When the parent material is less than 40 mm thick and the temperature is between (-) 5 Deg. C and 0 Deg. C, the surface around the joint to a distance of 100 mm or 4 times the thickness of the material, whichever is greater, shall be preheated till it is handwarm. When the parent material is more than 40 mm thick, the temperature of the area mentioned above shall be in no case be less than 20 Deg.C. All requirements regarding preheating of the parent material shall be in

accordance with the relevant Indian Standard.

3.3.7 Peening

Where required, intermediate layers of multiple-layer welds may be peened with light blows from a power hammer, using a round-nose tool. Peening shall be done after the weld has cooled to a temperature warm to the hand. Care shall be exercised to prevent scaling or flaking of weld and base metal from over peening.

3.3.8 Equipment

These shall be capable of producing proper current so that the operator may produce satisfactory welds. The welding machine shall be of a type and capacity as recommended by the manufacturers of electrodes or as may be approved by the engineer.

3.4 FINISH

Column splices and butt joints of compression members depending on contact for stress transmission shall be accurately machined and close-butted over the whole section with a clearance not exceeding 0.2 mm locally at any place. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken that those connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 2.0 mm.

3.5 SLAB BASES AND CAPS

Bases and caps fabricated out of steel slabs, except when cut from material with true surface, shall be accurately machined over the bearing surface and shall be in effective contact with the end of the stanchion. A bearing face which is to be grouted direct to a foundation need not be machined if such face is true and parallel to the upper face. To facilitate grouting, holes shall be provided, where necessary, in stanchion bases for the escape of air.

3.6 LACING BARS

The ends of lacing bars shall be neat and free from burrs.

3.7 SEPARATORS

Rolled section or built-up steel separators or diaphragms shall be required for all double beams except where encased in concrete, in which case, pipe separators shall be used.

3.8 BEARING PLATES

Provision shall be made for all necessary steel bearing plates to take up reaction of beams and columns and the required stiffeners and gussets whether or not specified in Drawings.

3.9 ARCHITECTURAL CLEARANCES

Bearing plates and stiffener connections shall not be permitted to encroach on the designed architectural clearances.

3.10 SHOP CONNECTIONS

(a) All shop connections shall be welded as specified on the Drawings.

(b) Certain connections, specified to be shop connections, may be changed to field connections if desired by the Engineer for convenience of erection and the Contractor will have to make the desired changes.

3.11 CASTINGS

Steel castings shall be annealed.

3.12 SHOP ERECTION

The steelwork shall be temporarily shop-erected complete or as directed by the Engineer so that accuracy of fit may be checked before despatch. The

parts shall be shop-erected with a sufficient number of parallel drifts to bring and keep the parts in place. In case of parts drilled or punched using steel jigs to make all similar parts interchangeable, the steelwork shall be shop erected in such a way as will facilitate the check of interchange ability.

3.13 SHOP PAINTING

3.13.1 General

Unless otherwise specified, steelwork which will be concealed by interior building finish need not be painted; steelwork to be encased in concrete shall not be painted. Unless specifically exempted, all other steelwork shall be given one coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned, in accordance with the following paragraph, by brush, spray, roller coating, flow-coating or dipping as may be approved by the Engineer.

After inspection and approval and before leaving the shop, all steelwork specified to be painted shall be cleaned by hand-wire brushing or by other mechanical cleaning methods to remove loose mill scale, loose rust, weld slag or flux deposit, dirt and other foreign matter. Oil and grease deposits shall be removed by solvent. Steelwork specified to have no shop paint shall, after fabrication, be cleaned of oil or grease by solvent cleaners and be cleaned of dirt and other foreign material by through sweeping with a fibre brush.

After completion of the precleaning, the metal surface shall immediately painted with red oxide zinc chromate primer conforming to IS : 2074.

In highly corrosive environment, all steelwork shall be given a coat of shop paint, applied thoroughly and evenly to dry surfaces which have been cleaned by sand blasting to SA 2/1/2 grade minimum. The shop paint shall be epoxy rasin based zinc rich primer such as Blast Steel EZ1 of Shalimer Paint Limited.

3.13.2 Inaccessible parts

Surfaces not in contact, but inaccessible after assembly, shall receive two coats of shop paint, positively of different colours to prove application of two coats before assembly. This does not apply to the interior of sealed hollow sections.

3.13.3 Contact surfaces

Contact surface shall be cleaned in accordance with Sub-clause 3.13.1 before assembly.

3.13.4 Finished surfaces

Machine finished surfaces shall be protected against corrosion by a rust inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.

3.13.5 Surfaces adjacent to field welds

Unless otherwise provided for, surfaces within 50 mm of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

3.14 GALVANIZING

3.14.1 General

Structural steelwork for switchyard or other structures as may be specified in the Contract shall be hot dip galvanized in accordance with the American Society for Testing and Materials Specification ASTM-A 123 or IS : 2629 - Recommended practice for Hot-Dip Galvanising of Iron and steel. Where the steel structures are required to be galvanized the field connection materials like bolts, nuts and washers shall also be galvanized.

3.14.2 Surface Preparation

All members to be galvanized shall be cleaned, by the process of pickling of rust, loose scale, dirt, oil, grease, slag and spatter of welded areas and other foreign substances prior to galvanizing. Pickling shall be carried out by immersing the steel in an acid bath containing either sulphuric or hydrochloric acid at a suitable concentration and temperature.

The concentration of the acid and the temperature of the bath can be varied, provided that the pickling time is adjusted accordingly.

The pickling process shall be completed by thoroughly rinsing with water, which should preferably be warm, so as to remove the residual acid.

3.14.3 Procedure

Galvanizing shall be carried out by hot dip process in a proper and uniformly heated bath. It shall meet all the requirements when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 - Specification for Hot-dip zinc coatings on Structural Steel & other allied products.

After finishing the threads of bolts, galvanizing shall be applied over the entire surface uniformly. The threads of bolts shall not be machined after galvanizing and shall not be clogged with zinc. The threads of nuts may be tapped after galvanizing but care shall be taken to use oil in the threads of nuts during erection.

The surface preparation for galvanizing and the process of galvanizing itself, shall not adversely affect the mechanical properties of the materials to be galvanized. Where members are of such lengths as to prevent complete dipping in one operation, great care shall be taken to prevent warping.

Materials on which galvanizing has been damaged shall be acid stripped and re-galvanized unless otherwise directed, but if any member becomes damaged after having been dipped twice, it shall be rejected. Special care shall be taken not to injure the skin on galvanized surfaces during transport

and handling. Damages, if occur, shall be made good in accordance with the provisions of this Specification or as directed by the Engineer.

4.0 INSPECTION, TESTING, ACCEPTANCE CRITERIA AND DELIVERY

4.1 INSPECTION

Unless specified otherwise, inspection to all work shall be made by the Engineer or Engineer's representative at the place of manufacture prior to delivery. The Engineer or his representative shall have free access at all reasonable times to those

parts of the manufacturer's works which are concerned with the fabrication of the steelwork under this Contract and he shall be afforded all reasonable facilities for satisfying himself that the fabrication is being done in accordance with the provisions of this Specification.

The Contractor shall provide such labour, materials, electricity, fuel, water, stores, tools and plant, apparatus and instruments as may be required by the Engineer to carry out inspection and/or tests in accordance with the Contract.

The Contractor shall guarantee compliance with the provisions of this Specification.

4.2 TESTING AND ACCEPTANCE CRITERIA

4.2.1 General

The Contractor shall carry out sampling and testing in accordance with the relevant Indian Standards and as supplemented herein for the following items at his own cost, unless otherwise specified in the Contract. The Contractor shall get the specimens tested in a laboratory approved by the Engineer and submit to the Engineer the test results in triplicate within 3 (three) days after completion of the test.

4.2.2 Steel

All steel supplied by the Contractor shall conform to the relevant Indian

Standards. Except otherwise mentioned in the Contract, only tested quality steel having mill test reports shall be used. In case unidentified steel materials are permitted to be used by the Engineer, random samples of materials will be taken from each unidentified lot of 50 M.T. or less of any particular section for tests to conform to relevant Indian Standards.

All material shall be free from all imperfections, mill scales, slag intrusions, laminations, pittings, rusts etc. that may impair their strength, durability and appearance.

4.2.3 Testing Criteria for checking Lamination in raw steel plates

All raw steel plate of thickness more than 20 mm supplied by the contractor shall be checked against lamination before procurement & prior to commencement of fabrication work in the following ways as directed by the Engineer.

(a) Ultrasonic testing along the edge of specified points of the plates shall be carried out to delete lamination in the plates, if any.

(b) If the results of the tests in (a) are not satisfactory, the whole area of the plates shall be checked by ultrasonic testing at specified nodal points formed at equidistant grid locations. The spacing of the grids shall be determined from tests in (a) or as directed by the Engineer.

If the results of the above tests are not satisfactory, the plates shall not be taken up for fabrication work. Even after fabrication at shop, if the Engineer requires any ultrasonic testing to detect lamination of plates, the same shall be carried out by the Contractor. If the plates in the fabricated item is found to be laminated, the component will be rejected

4.2.4 Welding

All electrodes shall be procured from reliable manufacturers with test certificates. The correct grade and size of electrode which has not deteriorated in storage shall be used. The inspection and testing of welding shall be performed in accordance with the provisions of the relevant Indian Standards or other equivalents. For every 50 tonnes of welded fabrication, the Engineer may ask for at least 1 (one) test-destructive or non-

destructive including X-ray, ultrasonic test or similar. In the event of further tests as may be desired by the Engineer, if the results are found to be unsatisfactory; and if the test shows no defect. In cases of the test results showing deficiency, the Engineer shall have option to reject or instruct any remedial measures to be taken.

4.2.5 Bolts, nuts and washers

All bolts, nuts and washers shall be procured from reputed manufacturer approved by the Engineer and shall conform to the relevant Indian Standards. If desired by the Engineer, representative samples of these materials may have to be tested in an approved laboratory and in accordance with the procedures described in relevant Indian Standards.

4.2.6 Shop painting

All paints and primers shall be of standard quality and procured from approved manufacturers and shall conform to the provisions of the relevant Indian Standards.

4.2.7 Galvanizing

All galvanizing shall be uniform and of standard quality when tested in accordance with IS:2633 - Method for testing uniformity of coating on Zinc Coated Articles and IS:4759 -specification for Hot-Dip Zinc Coatings on Structural Steel & other allied products.

4.3 TOLERANCE

The tolerances on the dimensions of individual rolled steel components shall be as specified in IS:1852 - specification for rolling and Cutting Tolerances for Hot-rolled Steel Products. The tolerances on straightness, length etc. of various fabricated components (such as beams and girders, columns, crane gantry girder etc.) of the steel structures other than steel railway & road bridges, structures subjected to dynamic loading (like wind, seismic etc.) and thin walled construction (like box girders) shall be as specified in IS:7215 - Tolerances for Fabrication of Steel Structures.

4.4 ACCEPTANCE

Should any structure or part of a structure be found not to comply with any of the provisions of this Specification, the same shall be liable to rejection. No structure or part of the structure, once rejected, shall be offered again for test, except in cases where the Engineer considers the defects rectifiable. The Engineer may, at his discretion, check the test results obtained at the Contractor's works by independent tests at an approved laboratory and should the items, so tested, be found to be unsatisfactory.

When all tests to be performed in the Contractor's shop under the terms of this contract have been successfully carried out, the steelwork will be accepted forthwith and the Engineer will issue an acceptance certificate, upon receipt of which, the items will be shop painted, packed and despatched. No item to be delivered unless an acceptance certificate for the same has been issued. The satisfactory completion of these tests or the issue of the certificates shall not bind the Owner to accept the work, should it, on further tests before or after erection, be found not in compliance with the Contract.

4.5 DELIVERY OF MATERIALS

4.5.1 General

The Contractor will deliver the fabricated structural steel materials to site with all necessary field connection materials in such sequence as will permit the most efficient and economical performance of the erection work the Owner may prescribe or control the sequence of delivery of materials, at his own discretion

4.5.2 Marking

Each separate piece of fabricated steelwork shall be distinctly marked on all surfaces before delivery in accordance with the markings shown on approved erection drawings and shall bear such other marks as will further facilitate identification and erection.

4.5.3 Packing and Shipping

All projecting plates or edges and all ends of members of joints shall be stiffened, all straight members and plates, shall be bundled, all screwed ends and machined surfaces shall be suitably packed and all bolts, nuts, washers, and small loose parts shall be packed separately in order to prevent damage or distortion during shipping.

Shipping shall be strictly in accordance with the sequence stipulated in the agreed programme. Payment may be held up for items sent in advance of the sequence till they could be erected. The Contractor shall include and provide for in his rates, the freight and other charges for despatching the materials to the worksite and also for securely protecting and packing the materials to avoid loss or damage during transport by rail, road or water. All packing shall allow for easy removal and checking at site. Special precautions shall be taken against rusting, corrosion, breakage or damage otherwise of the materials. All parts shall be adequately braced to prevent damage in transit.

Each bundle, bale or package delivered under this contract shall be marked on as many sides as possible and such distinct marking (all previous irrelevant markings being carefully obliterated) shall show the following:-

(a) Name and address of the consignee

(b) Name and address of the consignor

(c) Gross weight of the package in tonnes and its dimensions.

(d) Identification marks and/or number of the package

(e) Custom registration number, if required.

All markings shall be carried out with such materials as would ensure quick drying and indelibility.

Each component or part or piece of material when shipped, shall be indelibly marked and/or tagged with reference to assembly drawings and

corresponding piece numbers.

Each packing case shall contain in duplicate in English a packing list pasted on to the inside of the cover in a water-proof envelope, quoting especially:

(a) Name of the Contractor

(b) Number and date of the Contract

(c) Name of the office placing the contract

(d) Nomenclature of stores

(e) A schedule of parts or pieces, giving the parts or piece number with reference to assembly drawings and the quantity of each.

The shipping dimensions of each package shall not exceed the maximum dimensions permissible for transport over the Indian Railways/Roads.

After delivery of the materials at site, all packing materials shall automatically become the property of the Owner.

Notwithstanding anything stated hereinbefore, any loss or damage resulting from inadequate packing shall be made good by the Contractor When facilities exist, all shipments shall be covered by approved Insurance Policy for transit at the cost of the Contractor.

The contractor shall ship the complete materials or part on board a vessel belonging to an agency approved by the Owner or on rail and/or road transport as directed. The Contractor shall take all reasonable steps to ensure correct appraisal of freight rates, weights and volumes and in no case will the Owner be liable to pay any warehouse, wharfage, demurrage and other charges.

If, however, the Owner has to make payment of any of the above mentioned charges, the amount paid will be deducted from the progressive bills of the Contractor.

Necessary advice regarding the shipment with relevant details shall reach the Engineer at least a week in advance.

5.0 INFORMATION TO BE SUBMITTED

5.1 WITH TENDER

The following information are required to be submitted with the Tender:

(a) Progress Schedule

The Contractor shall quote in his Tender a detailed schedule of progress of work and total time of completion, itemizing the time required for each of the following aspects of work.

(i) Preparation and approval of shop drawings.

(ii) Procurement of materials

(iii) Fabrication and shipping of all anchor bolts

(iv) Fabrication and shipping of main steelwork

(v) Fabrication and shipping of steelwork for bunkers. Tanks and/ or silos as applicable.

(vi) Fabrication and shipping of all other remaining steel work including miscellaneous steelwork

(vii) Final date of completion of all shipments.

Time required for completion being one of the main criteria for selecting the successful bidder, it is desired that the bidder quotes the minimum time required by him for completing the work.

(b) Shop

Location of the Tenderer's fabrication workshop giving details of

equipment, manpower, the total capacity and the capacity that will be available exclusively for this contract shall be submitted

(c) Matching Steel

A rough indication of the quantities and details of matching steel sections required to start the work shall be furnished.

5.2 AFTER AWARD

After award of the Contract the successful Tenderer is to submit the following:

(a) Complete fabrication drawings, material lists, cutting lists, bolt lists, field welding schedules based on the design drawings in accordance with the approved schedule.

(b) Monthly Progress Report with necessary photographs in six (6) copies to reach the Engineer on or before the 7th day of each month, giving the upto date status of preparation of detailed shop drawings, bill of materials, procurement of materials, actual fabrication done, shipping and all other relevant information.

(c) Results of any test as and when conducted and as required by the Engineer.

(d) Manufacturer's mill test report in respect of steel materials, bolts, nuts and electrodes as may be applicable.

VOLUME VI-B

SECTION – 5

ERECTION OF STRUCTURAL STEELWORK

CONSULTANT : PROCON ENGINEERS

CONTENTS

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1.0 SCOPE

This specification covers the erection of structural steelwork including receiving and taking delivery of fabricated structural steel materials arriving at Site and installing the same in position, painting and grouting the stanchion bases all complete as per Drawings, this Specification and other provision of the Contract.

2.0 GENERAL

2.1 WORK TO BE PROVIDED FOR BY THE CONTRACTOR

The work to be provided for by the Contractor, unless otherwise specified in the Contract, shall include but not be limited to the following:-

(a) The Contractor shall provide all construction and transport equipment, tools, tackle, consumables, materials, labour and supervision required for the erection of the structural steelwork.

(b) Receiving, unloading, checking and moving to storage yard at Site including prompt attendance to all insurance matters as necessary for all fabricated steel materials arriving at Site. The Contractor shall pay all demurrage and/or wharf age charges etc. on account of default on his part.

(c) Transportation of all fabricated structural steel materials from Site storage yard, handling, rigging, assembling, bolting, welding and satisfactory installation of all fabricated structural steel materials in proper location according to approved erection drawings and/or as directed by the Engineer. If necessary suitable temporary approach roads to be built for transportation of fabricated steel structures.

(d) Checking center lines, levels of all foundation blocks including checking line, level, position and plumb of all bolts and pockets. Any defect observed in the foundation shall be brought to the notice of the Engineer. The Contractor shall fully satisfy himself regarding the correctness of the foundations before installing the fabricated steel structures on the foundation blocks.

(e) Aligning, plumbing, levelling, bolting, welding and securely fixing the fabricated steel structures in accordance with the Drawings or as directed by the Engineer.

(f) Painting of the erected steel structures if required by the Contract.

(g) All minor modifications of the fabricated steel structures as directed by the Engineer including but not limited to the following :

(i) Removal of bends, kinks, twists etc. for parts damaged during transport and handling.

(ii) Cutting, chipping, filling, grinding etc. if required for preparation and finishing of site connections.

(iii) Reaming of holes for use of higher size bolt if required.

(iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication. Welding in place of bolting will be permitted only at the discretion of the Engineer.

(v) Refabrication of parts damaged beyond repair during transport and handling or Refabrication of parts which are incorrectly fabricated.

(vi) Fabrication of parts omitted during fabrication by error, or subsequently found necessary.

(vii) Drilling of holes which are either not drilled at all or are drilled in incorrect location during fabrication.

(viii) Carry out tests in accordance with this Specification if directed.

2.2 WORK BY OTHERS

No work under this Specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.3 CODES AND STANDARDS

All work under this Specification shall, unless specified otherwise, conform to the latest revisions and/or replacements of the following or any other Indian Standard Specification and codes of Practice of equivalent:-

(a) IS-800 : Code of Practice for general construction in steel

(b) IS-456 : Code of Practice for plain or reinforced concrete

(c) IS-7205 : Safety Code for erection of Structural Steel work

(d) IS-12843 : Tolerance for erection of Steel Structures

2.4 CONFORMITY WITH DESIGNS

The Contractor will erect the entire fabricated steel structure, align all the members, complete all field connections and grout the foundations all as per the provisions of this specification and the design criteria detailed in the approved erection drawings and/or other stated document. All work shall conform to the provisions of the relevant Indian Standard Specifications and/or the instructions of the engineer. . Where specific Indian Standard is not available, the most stringent specification from the relevant American/German/British Standards shall be adopted.

The testing and acceptance of the erected structures shall be in accordance with the provisions of this Specification and/or the instructions of the Engineer.

2.5 MATERIAL

2.5.1 General

The Contractor will check the quantity, quality and the sizes of the fabricated materials and verify the adequacy of the same in accordance with the Drawings and Specifications. The Contractor shall make good any deficiency, if detected, either by repair or with fresh material as may be directed by the Engineer.

All consumables like oxygen and acetylene gas, paints, fuels, lubricants, oil, grease, cement, sand, aggregates and any other material that may be required for the execution of the works in accordance with the contract will be supplied by the contractor for erection work and will be deemed to have been included in this rates.

2.5.2 Materials to conform to Indian Standards

All materials required to be supplied by the Contractor under this Contract shall conform to the relevant Indian Standard Specifications.

2.6 STORAGE OF MATERIALS

2.6.1 General

All material shall be so stored as to prevent deterioration and to ensure the preservation of their quality and fitness for use in the works. Any material which has been deteriorated or damaged beyond repairs and has become unfit for use shall be removed immediately from the site, failing which, the Engineer shall be at liberty to get the materials removed by agency.

2.6.2 Yard

The Contractor will have to establish a suitable yard in an approved location at site for storing the fabricated steel structures and other materials which will be delivered to him by the Owner according to the Contract. The yard shall have proper facilities like, drainage, lighting, suitable access for large cranes, trailers and other heavy equipments. The yard shall be fenced all around with security arrangement and shall be of sufficiently large area to permit systematic storage of the fabricated steel structures without overcrowding and with suitable access for cranes, trailers and other equipment for use in erection work in proper sequence in accordance with the approved programme of work. The Tendered should visit the site prior to submission of his Tender to acquaint himself with the availability of land and the development necessary by way of filling, drainage, access roads, fences, sheds etc. all of which shall be carried out by the Contractor as directed by the Engineer.

2.6.3 Covered Store

All field connection materials, paints, cement etc. shall be stored on well designed racks and platforms off the ground in a properly covered store building to be built.

2.7 QUALITY CONTROL

The contractor shall establish and maintain quality control procedures for different items of work and materials as may be directed by the Engineer to assure compliance with the provisions of the Contract and shall submit the records of the same to the Engineer. The quality control operation shall include but not be limited to the following items of work:-

(a) Erection: Lines, levels, grades, plumbs, joint characteristics including tightness of bolts.

(b) Grouting: Cleaning and roughness of foundation, quality of materials used for grouting, admixtures, consistency and strength of grout.

(c) Painting : Preparation of surface for painting, quality of primers and paints, thinners, application and uniformity of coats.

The Contractor shall salvage, collect and deliver all the packing materials to the Owner.

3.0 WORKMANSHIP

3.1 ERECTION

3.1.1 Plant and equipment

The suitability and adequacy of all erection tools and plant and equipment proposed to be used shall be efficient, dependable, in good working condition and shall have the approval of the Engineer.

3.1.2 Method and sequence of erection

The method and sequence of erection shall have the prior approval of the Engineer. The Erection shall arrange for most economical method and sequence available to him consistent with the Drawings and Specifications and such information as may be furnished to him prior to the execution of the Contract.

3.1.3 Temporary bracing

Unless adequate bracing is included as a part of the permanent framing, the erector during erection shall install temporary guys and bracings where needed to secure the framing against loads such as wind or seismic forces comparable in intensity to that for which the structure has been designed, acting upon exposed framing as well as loads due to erection equipment and erection operations.

If additional temporary guys are required to resist wind or seismic forces acting upon components of the finished structure installed by others during the course of the erection of the steel framing, arrangement for their installation by the erector shall be made.

The responsibility of the Contractor in respect of temporary bracings and guys shall cease when the structural steel is once located, plumbed, levelled, aligned and grouted within the tolerances permitted under the specification and guyed and braced to the satisfaction of the Engineer.

3.1.4 Temporary floors for buildings

It shall be the responsibility of the Contractor to provide free of cost planking and to cover such floors during the work in progress as may be required by any Act of Parliament and/or by-laws of state, Municipal or other local authorities.

3.1.5 Setting out

Positioning and levelling of all steelwork, plumbing of stanchions and placing of every part of the structure with accuracy shall be in accordance

with the approved Drawings and to the satisfaction of the Engineer. Concrete foundations, where required, shall be made by other agencies. Anchor bolts and other anchor steel shall be embedded by other agencies. The Contractor shall check the positions and levels of the anchor bolts, etc. before concreting and get them properly secured against disturbance during pouring operations. He shall remain responsible for correct positioning. For heavy columns, etc. the Contractor shall set proper screed bars if desired by the Engineer, to maintain proper level.

Each tier of column shall be plumbed and maintained in a true vertical position subject to the limits of tolerance allowable under this Specification.

No permanent field connections by bolting or welding shall be carried out until proper alignment and plumbing has been attained.

3.1.6 Field bolting

All relevant portions in respect of bolted construction of the Specification for Fabrication of Structural Steelwork applicable to the Project shall also be applicable for field bolting in addition to the following:

Bolts shall be inserted in such a way so that they may remain in position under gravity even before fixing the nut. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible materials. When assembled, all joint surfaces, including those adjacent to the washers shall be free of scales except tight mill scales. They shall be free of dirt, loose scales, burns, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint, lacquer, or galvanizing.

All high tensile bolts shall be tightened to provide, when all fasteners in the joint are tight, the required minimum bolt tension by any of the following methods.

(a) Turn-of-nut method

When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a "snug tight" condition to ensure that the parts of the joint are brought into good

contact with each other. "snug tight" is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table-1 with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.

TABLE - I

SR. NO.	BOLTS LENGTH NOT Exceeding 8 x dia. or 200 mm	BOLT LENGTH Exceeding 8xdia. or 200 mm	REMARKS
(i)	1/2 turn	2/3 turn	Nut rotation is relative to bolt regardless of the element (nut or bolt) being tur- ned. Tolerance on rotation – 30 over or under.

Bolts may be installed without hardened washers when tightening is done by the turn-of-nut method. However, normal washers shall be used.

Bolts tightened by the turn-of-nut method may have the outer face of the nut match-marked with the protruding bolt point before final tightening, thus affording the inspector visual means of noting the actual nut rotation. Such marks can be made by the wrench operator by suitable means after the bolts have been brought up snug tight.

(b) Torque Wrench tightening

When torque wrenches are used to provide the bolt tensions, the bolts shall be tightened to the torques specified in TABLE - II. Nuts shall be in tightening motion when torque is measured. When using torque wrenches to install several bolts in a single joint, the wrench shall be returned to touch up bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the required tension.

TABLE - II

SR. NO.	Nominal Bolt Diameter (mm)	Torque to be applied (Kg.M) for bolt class 8.8 of IS : 1367
(i)	20	59.94
(ii)	22	81.63
(iii)	24	103.73

NOTE:

The above torque values are approximate for providing tensions of 14.7 MT for 20 mm dia., 18.2 MT for 22 mm dia; and 21.2 MT for 24 mm dia. bolts under moderately lubricated condition. The torque wrench shall be calibrated at least once daily to find out the actual torque required to produce the above required tension in the bolt by placing it in a tension indicating device. This torques shall be applied for tightening the bolts on that day with the particular torque wrench.

In either of the above two methods, if required, for bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating.

Impact wrenches if used shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately ten seconds.

Holes for turned bolts to be inserted in the field shall be reamed in the field. All drilling and reaming for turned bolts shall be done only after the parts to be connected are assembled. Tolerances applicable in the fit of the bolts shall be in accordance with relevant Indian Standard Specifications. All other requirements regarding assembly and bolt tightening shall be in accordance with this sub clause.

3.1.7 Field Welding

All field assembly and welding shall be carried out in accordance with the requirements of the specification for fabrication work applicable to the project, excepting such provisions therein which manifestly apply to shop conditions only. Where the fabricated structural steel members have been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

3.1.8 Holes, cutting and fitting

No cutting of sections, flanges, webs, cleats, bolts, welds etc. shall be done unless specifically approved and/or instructed by the Engineer.

The erector shall not cut, drill or otherwise alter the work of other trades, or his own work to accommodate other trades, unless such work is clearly specified in the Contract or directed by the Engineer. Wherever such work is specified the Contractor shall obtain complete information as to size, location and number of alterations prior to carrying out any work.

3.2 DRIFTING

Correction of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets will be considered as permissible. For this, light drifting may be used to draw holes together and drills shall be used to enlarge holes as necessary to make connections. Reaming, that weakens the member or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins and reamers shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of gas cutting torches at erection site is prohibited.

3.3 Grouting of stanchion bases and bearings of beams and girders on stone, brick or concrete (Plain or reinforced)+

Grouting shall be carried out with Ordinary Cement grout as described below:

The mix shall be one (1) part cement and one (1) part sand and just enough water to make it workable. The positions to be grouted shall be cleaned thoroughly with compressed air jet and wetted with water and any accumulated water shall be removed. These shall be placed under expert supervision, taking care to avoid air-locks. Edges shall be finished properly. If the thickness of grout is 25 mm or more, two (2) parts of 6 mm down graded stone chips may be added to the above noted cement-sand group mix, if required, by the Engineer or shown on the drawings.

Admixtures like aluminium powder, "ironite" may be required to be added to the grout to enhance certain desirable properties of the grout.

Alternatively, the grouting may be done with non-shrink high strength free flow cementious grout (ready mixed) like “Sika grout - 214", or "Anchor NSG" or approved equivalent.

No grouting shall be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are tied in position.

Whatever method of grouting is employed, the operation shall not be carried out until the steelwork has been finally levelled and plumbed, the stanchion bases being supported meanwhile by steel wedges, and immediately before grouting, the space under steel shall be thoroughly cleaned.

3.4 PAINTING AFTER ERECTION

Field painting, if required to be done by the erection Contractor, shall only be done after the structure is erected, levelled, plumbed, aligned and grouted in its final position, tested and accepted by the Engineer. However, touch up paintings, making good any damaged shop painting and completing any unfinished portion of the shop coat shall be carried out by the erection Contractor to the Owner. The materials and specification for such painting in the field shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable for the project.

Painting shall not be done in rainy or foggy weather or when humidity is such as to cause condensation on the surfaces to be painted. Before painting of steel, which is delivered unpainted, is commenced, all surfaces to be painted shall be dried and thoroughly cleaned from all loose scale and rust.

All field bolts, welds and abrasions to the shop coat shall be spot painted with the same paint used for the shop coat. Where specified, surfaces which will be in contact after site assembling shall receive a coat of paint (in addition to the shop coat, if any) and shall be brought together while the paint is still wet.

Surface which will be inaccessible after field assembly shall receive the full specified protective treatment before assembly. Bolts and fabricated steel members which are galvanized or otherwise treated and steel members to be encased in concrete shall not be painted.

The specification for paint and workmanship shall be in accordance with the requirements of the specification for fabrication of structural steelwork applicable to the project.

The number of coats and the shades to be used shall be as specified or as directed by the Engineer.

3.5 STAINLESS STEEL PLATE LINING IN BUNKER HOPPER

The hopper portion of the coal bunkers shall be lined with stainless steel plates of 3 mm thickness. The stainless steel shall be of AISI-316 quality. The

work includes supply, fabrication, welding and fixing of stainless steel lining plate to bunker M.S. plate as per drawing.

The stainless steel liner shall be fixed to the Bunker hopper by plug welding using special electrodes (such as, Inox-CW coding AWS-310-16 ISMBOS- 311 or Inox-D2 coding AWSE-309-16, ISMB 04-311 manufactured by Advani Oerlikon Ltd). Such plug welding shall be done by drilling 21.5 mm dia. holes at 300 mm centre to centre both ways. The plug welding shall be ground flush with the lining plate.

3.6 FINAL CLEANING UP

Upon completion of erection and before final acceptance of the work by the Engineer, the Contractor shall remove all false work, rubbish and all Temporary Works resulting in connection with the performance of his work.

3.7 SAFETY MEASURES DURING ERECTION

The safety measures to workmen and supervisors during all types of erection work (e.g., use of lifting appliances, slingning, welding, gas cutting, etc.) should be taken as per IS: 7205. When any statutory provisions exist, the same shall be complied with in addition to the provisions contained in the above code.

4.0 TESTING AND ACCEPTANCE CRITERIA

4.1 GENERAL

Loading tests shall be carried out on erected structures, if required by the Engineer, to check adequacy of fabrication and/or erection. Any structure or a part thereof found to be unsuitable for acceptance as a result of the test shall have to be dismantled and replaced with suitable member. In course of dismantling, if any damage is done to any other parts of the structure or to any fixtures, the same shall be made good by the Contractor responsible, to the satisfaction of the Engineer.

The structure or structural member under consideration shall be loaded with its actual dead load for as long a time as possible before testing and the tests shall be conducted as indicated in the following Sub-clauses 4.1.1, 4.1.2

and 4.1.3. The method of testing and application of loading shall be as approved by the Engineer.

4.1.1 Stiffness Test

In this test, the structure or member shall be subjected, in addition to its actual dead load, to a test load equal to1.5 times the specified superimposed load, and this loading shall be maintained for 24 hours. The maximum deflection attained during the test shall be within the permissible limit. If, after removal of the test load, the member or structure does not show a recovery of at least 80 per cent of the maximum strain or deflection shown during 24 hours under load, the test shall be repeated. The structure or member shall be considered to have sufficient stiffness, provided that the recovery after this second test is not less than 90 percent of the maximum increase in strain or deflection recorded during the second test.

4.1.2 Strength Test

The structure or structural member under consideration shall be subjected, in addition to its actual dead load, to a test load equal to the sum of the dead load and twice the specified superimposed load, and this load shall be maintained for 24 hours.

In the case of wind load, a load corresponding to twice the specified wind load shall be applied and maintained for 24 hours, either with or without the vertical test load for more severe condition in the member under consideration or the structure as a whole. Complete tests under both conditions may be necessary to verify the strength of the structure. The structure shall be deemed to have adequate strength if, during the test, no part fails and if on removal of the test load, the structure shows a recovery of at least 20 per cent of the maximum deflection or strain recorded during the 24 hours under load.

4.1.3 Structure of same design

Where several structures are built to the same design and it is considered unnecessary to test all of them, one structure, as a prototype, shall be fully tested, as described in previous Sub-clauses, but in addition, during the first application of the test load, particular note shall be taken of the strain or

deflection when the test load 1.5 times the specified superimposed load has been maintained for 24 hours. This information is required as a basis of comparison in any check test carried out on samples of the structure.

When a structure of the same type is selected for a check test, it shall be subjected, in addition to its actual dead load, to a superimposed test load, equal to 1.5 times the specified live load, in a manner and to an extent prescribed by the Engineer. This load shall be maintained for 24 hours, during which time, the maximum deflection shall be recorded. The check test shall be considered satisfactory, provided that the maximum strain or deflection recorded in the check test does not exceed by more than 20% of the maximum strain or deflection recorded at similar load in the test on the prototype.

4.1.4 Repair for subsequent test and use after strength tests

An actual structure which has passed the "Strength Test" as specified in Sub-clause 4.1.2 hereinbefore and is subsequently to be erected for use shall be considered satisfactory for use after it has been strengthened by replacing any distorted members and has subsequently satisfied the 'Stiffness Test' as specified in Sub-clause 4.1.1. Here in before.

4.2 TOLERANCES

Some variation is to be expected in the finished dimensions of structural steel frames. Unless otherwise specified, such variations are deemed to be within the limits of good practice when they are not in excess of the cumulative effect of detailed erection clearances, fabricating tolerances for the finished parts and the rolling tolerances for the profile dimensions permitted under the Specifications for fabrication of structural steelwork applicable to this Project and as specified below:

4.2.1 For Buildings Containing Cranes

	Component	Description	Variation Allowed
4.2.1.1	Main columns	(a) Shifting of column axis at foundation level with respect to building line	

	Component	Description	Variation Allowed
		(i) In longitudinal direction (ii) In lateral direction	3.0 mm 3.0 mm
		(b) Deviation of both major column axis from vertical between foundation and other member connection levels : (i) For a column upto and including 10M height	3.5 mm from true vertical
		(i) For a column greater than 10M but less than 40M height	3.5 mm from true vertical for any 10M length measured between connection levels, but not more than 7.0 mm per 30 m length.
		(c) For adjacent pairs of columns across the width of the building prior to placing of truss.	9 mm on true span.
		(d) For any individual column deviation of any bearing or resting level from levels shown on drawings.	3.0 mm
		(e) For adjacent pairs of columns either across the width of building or longitudinally level difference allowed between bearing or seating level supposed to be at the	3 mm

	Component	Description	Variation Allowed
		same level.	
4.2.1.2	Trusses	(a) Deviation at centre of span of upper chord member from vertical plane running through centre of bottom chord.	1/1500 of the span or not greater than 10 mm whichever is the least.
		(b) Lateral displacement of top chord at centre of span from vertical plane running through centre of supports.	1/250 of depth of truss or 20 mm whichever is the least.
4.2.1.3	Crane Girders & Tracks	(a) Difference in levels of crane rail measured between adjacent columns.	2.0 mm
		(b) Deviation to crane rail gauge	3.0 mm
		(c) Relative shifting of ends of adjacent crane rail in plan and elevation after thermit welding.	1.0 mm
		(d) Deviation of crane rail axis from centre line of web.	3.5 mm
4.2.1.4	Setting of Expansion gaps	At the time of setting of the expansion gaps, due regard shall be taken of the ambient temperature above or below 30 C. The coefficient of expansion or contraction shall be taken as 0.000012 per C per unit length.	
4.2.2	For Building without Cranes The maximum tolerances for line and level of the steel work shall be 3.0 mm on any part of the structure. The structure shall not be out of plumb		

more than 3.5 mm on each 10M section of height and not more than 7.0 mm per 30 M section.

These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

4.3 ACCEPTANCE

Structures and members which have passed the tests and conform to all requirements specified in the foregoing Sub-clause 4.1, 4.1.1, 4.1.2, 4.1.3 and 4.1.4 and other applicable provisions of this Specification and are within the limits of tolerances specified in Sub-clause 4.2 and/or otherwise approved by the Engineer shall be treated as approved and accepted for the purpose of fulfilment of the provisions of this Contract.

5.0 INFORMATION TO BE SUBMITTED

5.1 BEFORE TENDER

Along with the Tenders the Tenderers will be required to submit the following information:

5.1.1 Tentative Programme

The Tendered shall submit a tentative programme based on the information available in the Tender Document and visit to Site indicating the structure wise erection schedule proposed to be maintained by the Contractor to complete the job in time in accordance with the Contract.

5.1.2 Constructional Plant and Equipment, Tools, Temporary Works & Manpower

A detailed list of all Constructional Plant & Equipment like cranes, derricks, winches, welding sets, erection tools etc. along with their make, model, present condition and location available with the Tenderer which he will be able to employ on the job to maintain the progress of work in accordance with the Contract shall be submitted along with the Tender. The total number of each category of experienced personnel like fitters, welders, riggers etc. that he will be able to employ on the job shall also be

indicated.

5.1.3 Erection yard

A site plan showing the layout and location of the erection yard proposed to be established by the Tenderer shall be attached with the Tender indicating the storage space for fabricated steel materials, site-fabrication and repair shop, covered stores, offices, locations of erection equipments and other facilities. The Engineer shall have the right to modify the arrangement and location of the proposed yard to suit site conditions and the Contractor shall comply with the same without any claim whatsoever.

5.2 AFTER AWARD OF THE CONTRACT

After award of the contract, the Contractor shall submit the following:-

5.2.1 Detailed Programme

The Contractor shall submit a detailed erection programme for completion of the work in time in accordance with the Contract. This will show the target programme, with details of erection proposed to be carried out in each fortnight, details of major equipment required and an assessment of required strength of various categories of workers in a proforma approved by the Engineer.

5.2.2 Fortnightly Progress Report

The Contractor shall submit fortnightly progress reports in triplicate to the Engineer showing along with necessary photographs, 125 mm x 90 mm size, and all details of actual achievements against the target programme specified in Sub-clause 5.2.1 above. Any shortfall in the achievement in a particular fortnight must be made up within the next fortnight. Along with this report, the Contractor shall also furnish details of fabricated materials in hand at site and the strength of his workers.

VOLUME VI-B

SECTION-6

REINFORCED CONCRETE SINGLE FLUE STACK

CONSULTANT : PROCON ENGINEERS

CONTENT

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	GENERAL
3.0	EXECUTION
4.0	TESTING AND ACCEPTANCE CRITERIA
5.0	INFORMATION TO BE SUBMITTED

1.0 SCOPE

This specification covers plain and reinforced cement concrete work, steel flues and insulation work, painting and protective treatment work, connected with construction of RCC single flue Stack.

2.0 GENERAL

2.1 WORK TO BE PROVIDED FOR BY THE CONTRACTOR

Work to be provided by the Contractor, unless specified otherwise, shall include but shall not be limited to the following:

(a) Furnish all labour, supervision, services, insurance, material, power, Furnish all labour, supervision, services, insurance, material, power, construction equipment, approaches, transportation etc. required for the entire work.

(b) Design and prepare working drawings for formworks, scaffoldings, supports, staging hoisting arrangement for men and material etc. and submit them for approval.

(c) Prepare and submit for approval, as per approved schedule, detailed drawings for RCC work in shell, platforms at various levels, roof and ground floor and bending schedules for reinforcement bars, showing he positions and details of spacers, chairs, supports, hangers, openings etc.

(d) Prepare detailed fabrication and erection marking drawings for steel flues including flue expansion compensators, steel flue supports and restraint arrangements along with fittings and accessories and submit them for approval.

(e) Prepare and submit for approval detailed shop drawings, with list of materials and material specifications for Load Bearing Insulation Blocks and Lateral Restraint Insulation Blocks.

(f) Prepare and submit for approval detailed schemes for operations like material handling, placement of concrete erection of steel flues, fixing of insulations, installation, dismantling and maintenance of flue expansion compensator etc. and for items like approaches, services etc.

(g) Design and submit for approval mix proportions for concrete to be adopted on job.

(h) Furnish samples and submit for approval the results of tests for various properties of the following materials :

(i) Ingredients of concrete,

(ii) Concrete,

(iii) Acid/Chemical Resistant Tiles,

(iv) Castable refractories,

(v) Insulation materials,

(vi) Paints.

(vii) S/S liner.

(i) Provide all incidental items not specified or shown on drawings in particulars but reasonably implied or necessary for successful completion of the work in accordance with drawings and specifications.

(j) Produce, if directed by the Engineer, a guarantee, in approved proforma, for satisfactory performance, for a specified period, of material manufactured by specialist firms.

2.2 WORK BY OTHERS

No work under this specification will be provided for by agency other than the Contractor for this Contract unless specifically mentioned otherwise in the Contract.

2.3 CODES AND STANDARDS

All works under this Specification, unless specified otherwise, shall conform to the latest revisions/replacements of the following Indian Standard Codes, Criteria, Specifications, along with those mentioned therein. In case any particular aspect of work is not covered by Indian Standards, other standard specification, as may be specified by the Engineer, shall be followed. "IS Specification" shall mean Codes, Criteria etc. of ISI.

(a)	IS:6	:	Moderate heat duty fireclay refractories, Group-A.
(b)	IS:104	:	Ready mixed paint, brushing, zinc chrome, priming.
(c)	IS:158	:	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and heat resisting for general purposes.
(d)	IS:195	:	Specification for fire clay mortar for laying fireclay refractory bricks.
(e)	IS:269	:	Ordinary and low heat Portland cement.
(f)	IS:383	:	Coarse and fine aggregates from natural sources for concrete.
(g)	IS:432	:	Mild steel and medium tensile steel bars.
(h)	IS:456	:	Code of practice for plain and reinforced concrete.
(i)	IS:516	:	Methods of test for strength of concrete.
(j)	IS:732	:	Code of practice for electrical wiring installations (System Voltage not exceeding

650 Volts).

(k)	IS:800	:	Code of practice for general construction in steel.
(l)	IS:813	:	Scheme of symbols for welding.
(m)	IS:814	:	Covered electrodes for metal arc welding of structural steel.
(n)	IS:816	:	Code of practice for use of metal arc welding for general construction in mild steel.
(o)	IS:817	:	Code of practice for training and testing of metal arc welders.
(p)	IS:818	:	Code of practice for safety and health requirements in electric and gas welding and cutting operations
(q)	IS:822	:	Code of procedure for inspection of welds.
(r)	IS:875	:	Draft Standard for Code of practice for structural safety of foundations.
(s)	IS:1139	:	Hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcements.
(t)	IS:1161	:	Steel tubes for structural purposes.
(u)	IS:1199	:	Methods of sampling and analysis of concrete.
(v)	IS:1200	:	Methods of measurement of building works.
(w)	IS:1230	:	Cast Iron Rainwater pipes and fittings.
(x)	IS:1239 (Part-I)	:	Mild steel tubes.
(y)	IS:1367	:	Technical supply conditions for threaded fasteners.

(z)	IS:1526	:	Sizes and shapes for firebricks (230 mm. series).
(aa)	IS:1554	:	Cables.
(bb)	IS:1566	:	Hard-drawn steel wire fabric for concrete reinforcement.
(cc)	IS:1608	:	Methods for tensile testing of steel products.
(dd)	IS:1730	:	Dimensions for steel plate, sheet and strip for structural and general engineering purposes.
(ee)	IS:1731	:	Dimensions for steel flats for structural and general engineering purposes.
(ff)	IS:1786	:	Cold-twisted steel bars for concrete reinforcement.
(gg)	IS:1791	:	Batch type concrete mixers.
(hh)	IS:1893	:	Criteria for Earthquake Resistant Design of Structures.
(ii)	IS:1947	:	Flood light.
(jj)	IS:1977	:	Structural steel (ordinary quality).
(kk)	IS:2062	:	Weldable structural steel.
(ll)	IS:2074	:	Ready mixed paint, red oxide - zinc chrome priming.
(mm)	IS:2309	:	Code of practice for the protection of buildings and allied structures against lightning.
(nn)	IS:2386 (Part-I)	:	Methods of test for aggregates for concrete. Particle size and shape.
(oo)	IS:2386 (Part-II)	:	Estimation of deleterious materials and organic impurities.

(pp)	IS:2386 (Part-III)	:	Specific gravity, density, voids, absorption and bulking.
(qq)	IS:2386 (Part-IV)	:	Mechanical properties.
(rr)	IS:2386 (Part-V)	:	Soundness.
(ss)	IS:2386 (Part-VI)	:	Measuring mortar making properties of fine aggregate.
(tt)	IS:2386 (Part-VII)	:	Alkali aggregate reactivity.
(uu)	IS:2386 (Part-VIII)	:	Petrographic examination.
(vv)	IS:2502	:	Code of practice for bending and fixing of bars for concrete reinforcement.
(ww)	IS:2505	:	Concrete vibrators, immersion type.
(xx)	IS:2506	:	Screed board concrete vibrators.
(yy)	IS:2633	:	Methods of testing uniformity of coating on zinc coated articles.
(zz)	IS:2722	:	Portable swing weighbatchers for concrete (single and double bucket type).
(aaa)	IS:2750	:	Steel scaffoldings.
(bbb)	IS:2751	:	Code of practice for welding of mild steel bars used for reinforced concrete construction.
(ccc)	IS:2950	:	Code of practice for design and construction of raft foundations.
(ddd)	IS:3025	:	Methods of sampling and test (Physical and Chemical) for water used in industry.
(eee)	IS:3043	:	Code of Earthing.
(fff)	IS:3144	:	Methods of Test for Mineral Wool Thermal Insulation Material.
(ggg)	IS:3346	:	Method for the determination of thermal conductivity of thermal insulation materials (two slab, guarded hot- plate method).

(hhh)	IS:3495 (Part-I to IV)	:	Method of test for clay building bricks.
(iii)	IS:3550	:	Methods of test for routine control for water used in industry.
(jjj)	IS:3558	:	Code of practice for use of immersion vibrators for consolidating concrete.
(kkk)	IS:3677	:	Unbonded rock and slag wool for thermal insulation.
(lll)	IS:4014 (Part-I&II)	:	Code of practice for steel tubular scaffolding.
(mmm)	IS:4031	:	Method of physical tests for hydraulic cement.
(nnn)	IS:4457	:	Ceramic Unglazed Vitreous acidresistant tiles.
(ooo)	IS:4634	:	Method for testing performance of batch-type concrete mixers.
(ppp)	IS:4687	:	Gland packing asbestos.
(qqq)	IS:4832	:	Chemical Resistant mortars.
(rrr)	IS:4860	:	Acid-resistant bricks.
(sss)	IS:4990	:	Plywood for concrete shuttering work.
(ttt)	IS:4998 (Part-I)	:	Criteria for design of reinforced concrete chimneys.
(uuu)	IS:5410	:	Cement paint, colour as required.
(vvv)	IS:5445	:	Long fluted machine reamers with Morse taper shanks.
(www)	IS:5495	:	Sizes and shapes for firebrick (300 mm. and higher series).
(xxx)	IS:6911	:	Stainless Steel plate, sheet and strip.
(yyy)	IS:8112	:	High strength ordinary portland cement.

(zzz) IS:8183 : Bonded Mineral Wool.

(aaaa) IS:9595 : Recommendation for Metal Arc Welding of Carbon and Carbon Manganese steels.

NEPA NO. 78 Code of protection against lightning.

The Indian Electricity Rules.

The requirements of Department of Civil Aviation, Govt. of India.

2.4 CONFORMITY WITH DRAWINGS AND SPECIFICATIONS

The contractor shall carry out all the work in strict accordance with the drawings stamped "Released for Construction" and specification issued to him and as per Contractor's detailed drawings approved by the Consulting Engineer. Prior to concreting, the Contractor shall prepare a check list on a set format of all items of work involved, and inform the Engineer well in advance so that the Engineer shall have the opportunity of satisfying himself if the works mentioned in the format are done according to drawings and specification, and he can allow the Contractor in writing to start pouring of concrete. The entire operation of concreting shall be carried on as per specification, to the complete satisfaction of the Engineer. No deviation from the drawings will be allowed unless otherwise directed by the Engineer in writing.

For Load Bearing Thermal Insulation block assembly and lateral restraint insulation block assembly, Contractor shall design sizes of all components of the blocks and details of their connections supply and fabricate the same in accordance with the approved shop drawings prepared by him.

For steelwork and metal work, the Contractor shall design all connections, inserts for scaffolding, supply and fabricate all steelwork and metal work and furnish all connection materials in accordance with approved shop drawings prepared by him and/or as instructed by the Engineer, keeping in view the maximum utilisation of the available sizes and shapes for metal components.

2.5 MATERIALS TO BE USED

2.5.1 General Requirement

All materials, whether to be incorporated in the work or to be used temporarily for the construction, shall conform to the relevant IS specifications unless stated otherwise and shall be of the quality approved by the Engineer.

2.5.2 Cement

Portland Cement shall be as per the requirements laid down in IS: 269.

2.5.3 Coarse Aggregate

Coarse aggregate shall be graded crushed or broken stone from approved sources, free from impurities and shall be screened free of dust and other deleterious matter. It shall conform to IS: 383 or IS: 515 and shall be washed clean, if necessary. The maximum size of coarse aggregate for stack superstructure shall be 25 mm down graded, unless otherwise stated (vide serial 5(b) of clause 3.03.06). Grading for a particular size shall conform to relevant IS Codes and shall be such as to produce a dense concrete of specified proportion and strength and shall be of consistency that will work readily into position without segregation.

2.5.4 Fine Aggregate

Fine aggregate shall be river or pit sand, free from any clay, earth, vegetable matters, salt or other impurities and shall be clean and fit for use, to the satisfaction of the Engineer. Sand acceptable for the work shall normally have a grading falling within the limits of one of the three grades, mentioned in the relevant IS Specifications.

2.5.5 Water

The water for both mixing and curing of concrete shall be clean, free from oil, acid, alkali, organic or other deleterious substances. Contractor shall test the water as and when required by the Engineer.

2.5.6 Reinforcement

Mild steel or Medium or High Tensile steel deformed bars specified for reinforcement shall conform to the latest relevant IS Specifications and shall be of tested quality under ISI Certification Scheme. The reinforcement shall be free from any oil, foreign material or mill or rust scales.

2.5.7 Steel Flue

2.5.7.1 All mild steel material to be used in construction of steel flue shall comply with IS:2062, IS:1239, IS:1367, IS:1608, IS:800 and with other relevant IS Specifications. The ultimate tensile strength of this steel shall not be less than 410 N/Sq.mm.

2.5.7.2 Stainless steel liners shall be fabricated using materials conforming to the requirements of relevant IS Specifications and/or AISI 316L or BS:1449 Part-2. Grade of Stainless steel shall be equivalent to BS:1449 (Part-2) 316 S.12.

2.5.7.3 Materials to be used for fabrication of Flue expansion compensator shall be suitable for the flue gas tempeature and shall be acid resisting.

The Expansion compensator shall comprise several layers of materials given below in order from the gas side.

(a) Two layer of insulation, each consisting of heavy weight texturized glass cloth impregnated with graphite suspension, having an approximate weight of 1.00 Kg/Sq.m

(b) A continuous filament glass cloth coated both sides with a flouro-elastomer having an approximate weight of 1.5 Kg/Sq.m.

(c) Two layers of PTFE (Poly Tetra Flouro-Ethylene) film of minimum thickness 0.15 mm each.

(d) A layer of glass felt of minimum thickness 10 mm and an approximate weight of 1.5 Kg/Sq.M.

2.5.8 Stainless steel Liners

Stainless steel liners shall be provided with a minimum of 5 m above the roof Top.

The portion of liner with stainless steel shall be provided with a grade of steel conforming to the requirements of AISI 316 or equivalent and the minimum thickness of the stainless steel liner shall be 8mm.

The individual cans of the liners shall be jointed together by butt welding internally all round for full strength, after connecting the flanged portion of the cans with high tensile treaded fasteners conforming to IS: 1367.

The bidder shall test all welds in the presence of the OWNER to meet the following requirements:

(a) The bidder shall test at random at least 10% of the butt welds by radiographic/ultrasonic testing method.

(b) At least 10% of the fillet welds shall be tested at random by dye penetration tests.

(c) 10% of the root welds for butt-welding shall be tested at random by dye penetration tests.

All tests shall be conducted in the presence of the ENGINEER IN CHARGE. If any test fails, the weld shall be cut out, remade and retested to the Engineer's satisfaction.

2.5.9 Paints

Paints to be used for shop coat of fabricated steel shall conform to the IS: 2074. Paint for treatment of outside face of Chimney with Cement water proof paint shall conform to IS: 5410.

2.5.10 Acid Resistant Tiles and Castable Refractories

Acid resistant tiles to be provided over roof of stack should conform to IS: 4457. Matching mortars to be used for tiles. Castable refractories shall be of hydraulic setting, rapid hardening type. It shall have refractory properties similar to Fire bricks conforming to IS:6, Group-A and working temperature shall be upto 1350 Deg.C.

2.5.11 Insulations

2.5.11.1 Thermal Insulation

The insulation shall be semi-rigid, resin bonded type, in the form of slabs and shall conform to IS: 8183. Blanket type insulation shall not be used. The density of insulation shall not be less than 64 kg/cu.m for resin bonded glass wool insulation and 100 kg/cu.m for resin bonded rock wool. The insulation thickness shall be determined based on the maximum ambient temperature, surface air velocity worked out based on the draught of ventilation air in the annular space between the flue liner and chimney shell, insulation surface emissivity of 0.3 and the insulation cold face maximum temperature not exceeding 55C. The draught of air in the annular space shall be the natural draught created by the heating of air by the flue liner and the air being vented out through the openings in the chimney shell. The increase in the annulus air temperature due to the rising heated air shall be taken into account while calculating the insulation thickness. The insulation thickness shall not be less than 100 mm, in any case, and shall be provided in two layers with the second layer of insulation covering the joints of the first layer. The insulation shall be wrapped on the outer-most surface with galvanised wire mesh.

2.5.11.2 At Load Bearing and Side Restraints of Flues

Load bearing insulation assembly to have (i) a properly machined mild steel plate with recess at its top for seating PTFE (Poly Tetra Fluoro Ethylene) sheets conforming to BS:5400 (ii) saddle plate (MS) in the middle having stainless steel plate fixed at its bottom surface and lead/elastomeric sheet at top, and (iii) top plate formed of two numbers insulation blocks each made of minimum 50mm thick rigid, non-combustible asbestos fibre reinforced lime-silica board (SINDANYO BLOCKS NATURAL GRADE CS-51) bonded to mild steel plates at top and bottom. For side restraints assembly of insulation blocks of SINDANYO Natural Grade CS-51 and stainless steel

plate shall be used. All stainless steel in these assemblies shall conform to AISI-316L and Mild steel to IS-2062. SINDANYO BLOCKS shall be suitable for operation at 320 Deg.C and shall primarily satisfy the following physical prolperties :

(a) Minimum compressive stress prior to onset of compression yield of not less than 12 N/Sq.mm.

(b) Minimum shear strength of 30 N/Sq.mm when tested in accordance with BS:3497-1979.

(c) Thermal conductivity shall not exceed 0.67 W/m Deg.C at a mean temperature of 200 Deg.C and its coeff. of linear expansion not to exceed 1.2 x 10^{-5} per Deg.C.

(d) Adhesive used for bonding purposes shall be of material with equivalent high temperature properties as approved by the Engineer. It may be of "Fortafix Fiborclad Adhesive" as manufactured by Fortafix Ltd., England.

2.6 STORAGE OF MATERIALS

2.6.1 General

All materials shall be so stored as to prevent deterioration and intrusion of foreign matter and to ensure the preservation of their quality and characteristics for the work. Any material, which is deteriorated or is damaged or is otherwise, considered defective by the Engineer, shall not be used for construction and shall be removed from site immediately, failing which the Engineer shall be at liberty to get the materials removed. The Contractor shall maintain an upto date accounts of receipt, issue and balance of all materials issued by the Owner.

2.6.2 Cement

Contractor shall store cement in water-tight and properly designed stores so that the Cement can be kept dry and the stock can be handled in rotation. The doors of stores shall be at least 30 cm. above G.L. Deteriorated cement

shall be removed immediately from the site. Not more than ten bags of cement shall be stacked one above the other.

2.6.3 Aggregate

Different materials shall be transported, handled and stored separately in such a manner as to prevent damage, deterioration or contamination. Stock piles of fine and coarse aggregates shall be allowed to drain, so that aggregates do not contain too much water.

2.6.4 Reinforcement

Reinforcement shall be stored preferably under cover and stacked off ground in size and grade-wise separate stacks for easy identification.

2.6.5 Steel, Metal and Fittings

All steel, metal and fittings to be used for fabrication and erection shall be stored sectionwise and lengthwise in separate stacks, off ground, so that they can be handled, inspected, measured and accounted for easily at any time. If required by the Engineer, the materials may have to be stored in a covered shed.

2.6.6 Paints

Paints shall be stored under cover, in air-tight containers. Paints supplied in sealed containers shall be used as soon as possible once the container is opened. Left over paints shall be kept in air-tight containers.

2.6.7 Steel Flue

Fabricated pieces of steel (flue) liner shall be stored systematically for ease of handling.

2.6.8 Insulation Material

All insulation materials like bearing insulation blocks, restraint insulation blocks, glass or mineral wool, asbestos ropes etc. shall be stored in packing

boxes, under covered shed, avoiding their coming in contact with objectionable matter.

2.7 QUALITY CONTROL

Contractor shall establish and maintain quality control for different items or work and materials as may be directed by the Engineer to assure compliance with contract requirement and submit to the Engineer records of the same. The Contractor shall submit all records and test results in original to the Engineer for his approval, if so desired by him.

The quality control operation shall include but shall not be limited to the following items of work:

(a)	Cement	:	Test to satisfy relevant IS Specifications if supplied by the Contractor.
(b)	Aggregate	:	Physical, Chemical and Mineralogical qualities, grading, moisture contents and impurities.
(c)	Water	:	Impurities Test.
(d)	Reinforcement	:	Material tests or certificates to satisfy relevant IS Specification if supplied by the Contractor.
(e)	Structural		Material tests or certificate to satisfy Steelrelevant IS Specification if supplied by the Contractor.
(f)	Steel flue		Material tests or certificate to satisfy relevant IS Specification if supplied by the Contractor.
(g)	Stainless		Material tests or certificate to satisfy Steel relevant IS Specification if supplied by the Contractor.
(h)	Acid Resistant		Compressive and tensile strength, acid tiles & mortar resistance and water absorption test.

(i)	Mortar	Compressive and tensile strength, adhesion and acid resistance test.
(j)	Insulation	Thermal conductivity, density, heat and acid resistance tests. Bearing capacity will be tested for bearing/restraint insulation blocks.

3.0 EXECUTION

3.1 CONCRETE

3.1.1 Trial Mix, Grades of Concrete

At least three weeks before commencing any concreting in the work the Contractor shall make trial mixes using samples of coarse aggregates, sand, water and cement, typical of those to be used in the work. A clean dry mixer shall be used for mixing and the first batch shall be discarded.

For guidance in designing the mix, standard tables for maximum allowable water-cement ratio, minimum cement content, maximum proportion of aggregates and limits of consistency may be used by the Contractor. The Contractor's design mix shall fall within limits of the following tables:

(a) Strength requirements of concrete: Table-2 of IS: 456-2000.

(b) Concrete Mix Proportion: Table-3 of IS: 456-2000.

(c) Minimum cement content/Cu.m. of finished concrete shall be as per Table 5 of IS 456-2000.

(d) Limit of consistency: Refer Table in Item 3.1.4 of this specification.

(e) Cement/Total Aggregate Ratio: As per the following table.

MIX PROPORTIONS (BY WEIGHT) EXPECTED TO GIVE DIFFERENT DEGREES OF WORKABILITY WITH DIFFERENT VALUES OF WATER - CEMENT RATIO (FOR GUIDANCE)
CEMENT/TOTAL AGGREGATES RATIOS

Sr.No.	Workability	Water /Cement Ratio	Ratio by Weight of Cement to Gravel Aggregate		Ratio by Weight of Cement To Crushed Stone Aggregate	
			20 mm.Size	38 mm.Size	20 mm.Size	38 mm.Size
(a)	Very Low	0.4	01:04.8	01:05.3	01:04.5	1:05
	Slump	0.5	01.:07.2	01:07.7	01:06.5	01:07.4
	0-25 mm.	0.6	01:09.4	1:10	01:07.8	01:09.6
		0.7	1:10	1:12	01:08.7	01:10.6
(b)	Low	0.4	01:03.9	01:04.5	01:03.5	1:04
	Slump	0.5	01:05.5	01:06.7	1:05	01:05.5
	25-50 mm.	0.6	01:06.8	01:07.4	01:06.3	1:07
		0.7	1:08	01:08.5	01:07.4	1:08
(c)	Medium	0.4	01:03.5	01:03.8	01:03.1	01:03.6
	Slump	0.5	01:04.8	01:05.7	01:04.2	1:05
	50-100 mm.	0.6	1:06	01:07.3	01:05.2	01:06.2
(d)	High	0.4	01:03.2	01:03.5	01:02.9	01:03.3
	Slump	0.5	01:04.4	01:05.2	01:03.9	01:04.6
	100-175 mm.	0.6	01:05.4	01:06.7	01:04.7	01:05.7
		0.7	01:06.2	01:07.4	01:05.5	01:06.5

NOTE-1: Notwithstanding anything mentioned above, the cement / Total aggregate ratio is not to be increased beyond 1:9 without specific permission of the Engineer.

It should be noted that such high aggregate cement ratios will be required for concretes of very low slump and high water-cement ratios which may be required to be used in mass concrete work only.

NOTE-2: The above figures are for guidance only, the actual cement/ aggregate ratios are to be worked out from the specific gravities of coarse aggregates and sand being used and from trial mixes. For each grade of concrete, a set of eighteen cubes shall be made. Of these not more than six may be made on any day and further, of the six cubes made in one day not more than two cubes may be made from any single batch. Nine of these cubes each representing a different batch of concrete shall be tested at the age of seven days and remaining at twenty eight days. The making of the cubes, their curing, storing, transporting and testing shall be in accordance with the relevant IS Specifications. The test shall be carried out in laboratory approved by the Engineer. If the average strength of the concrete cubes falls below the requirement, the method described above shall be repeated till acceptable results are obtained. The method may have to be repeated whenever there is a significant change in the quality of any of the ingredients for concrete, at the discretion of the Engineer.

3.1.2 Batching of Concrete

For controlled concrete, only weigh batching shall be allowed. All concrete ingredients, except water, shall be batched by weight, using an approved make of weigh batcher. Batching shall be accurate to 1/2 Kg. The batcher shall be tested for accuracy of calibration, first before commencement of work and at least once a fortnight or as directed by the Engineer thereafter. Water shall be batched by weight or by volume measures, as approved by the Engineer.

3.1.3 Mixing of Concrete

Materials for concrete shall be emptied in rotation into the mixer. When all the ingredients are in the drum, the drum will rotate for one minute for dry mixing. After that water shall be added in measured quantities in the

manner specified. The mixer shall then rotate for at least two minutes, or at least forty revolutions or until there is apparent uniform distribution of the materials and till the mass is uniform in colour. The entire content of the drum shall be discharged before the ingredients for the succeeding batch are fed into the drum. The mixer shall be thoroughly cleaned to the satisfaction of the Engineer, before a different quality of concrete is put through the mixer and also at the end of day's work.

3.1.4 Workability of Concrete

The degree of workability necessary to allow the concrete to be well consolidated and to be worked into the corners of formwork and around the reinforcement and embedments, and to give the required surface finish shall depend on the type and nature of structure and shall be based on experience and tests. 15 mm. to 40 mm. slump in chimney works shall be adopted subject to Engineer's approval unless stated otherwise (vide serial 1(d) of clause no. 3.3.6). The usual limits of consistency for various types of structure are given below:

LIMITS OF CONSISTENCY

Sr. No.	Degree of Workability	Slump in mm. with Standard Concrete		Use for which Concrete is suitable
		Min.	Max.	
(a)	Very Low	0	15	Large mass concrete work with heavy compaction equipment.
(b)	Medium	35	65	Deep and wide RCC structures with congestion of reinforcement and inserts.
(c)	High	65	100	Very narrow and deep RCC structures with congestion due to reinforcement and inserts.

NOTE: The above table is for guidance only. Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately, to keep the ratio of water to cement same, as adopted in trial mix design, for each grade of concrete.

The workability of concrete shall be checked at frequent intervals by slump tests. Alternatively, where facilities exist or if required by the Engineer, the compacting factor test, in accordance with IS:1199, shall be carried out.

3.1.5 Placing and Compaction of Concrete

Concreting shall proceed in a manner directed by the Engineer; concrete shall be placed in forms as soon as possible but in no case later than twenty minutes, after mixing.

The height of any single lift of concrete, for different structural members, shall be decided by the Engineer. The concrete shall be placed in the forms gently and not dropped from a height which may cause segregation of aggregates. Each layer of concrete shall be compacted fully before the succeeding layer is placed and separate batches shall follow each other so closely that the succeeding layer shall be placed and fully compacted before the layer immediately below has taken an initial set.

The concrete, after placing, shall be consolidated only by power driven vibrators. The vibrators shall be of a make and size, approved by the Engineer. In using the vibrator, the standard practice and the Engineer's directions, shall be followed.

Vibration shall begin as soon as one batch of concrete has been placed and shall continue till the entire section being poured has been thoroughly consolidated.

To secure even and dense surfaces, free from aggregate pockets, vibration shall be supplemented by tamping or rodding by hand in the corners of forms and along the form surfaces while the concrete is plastic, without damaging or endangering the stability of the formwork.

A sufficient number of spare vibrators including petrol vibrators shall be kept readily accessible to the place of deposition of the concrete to assure adequate vibration in case of breakdown of those in use.

3.1.6 Curing of Concrete

Curing of exposed surface of concrete shall commence immediately after the concrete has set. Exposed sides shall be covered with canvas etc. immediately after stripping of forms, and curing shall be continued for a period of not less than 14 days, reckoned from the date and hour of completion of concreting. All surfaces of the pour shall be kept wet with water at all times after concreting and till the curing period is over. The Contractor shall plan and employ proper equipment and sufficient labour considered adequate by the Engineer under able supervisor for curing.

3.1.7 Construction Joints

In concreting the chimney shell one full ring lift shall be completed in a day's pour. Before the formwork for the following pour starts the horizontal surface of the Chimney shell shall be chipped, cleaned and washed with water, and when the formwork is complete, the surface shall be cleaned and washed again and covered with 1:2 sand cement slurry before fresh concrete is placed. The horizontal construction joints shall be so arranged and made that they are regular and neat. No vertical joint shall be allowed. No separate payment shall be allowed to the Contractor for forming joints or chipping and cleaning them or cover with slurry prior to concreting. The number of construction joint shall be kept minimum and the spacing should not exceed three (3) meters. The Contractor shall submit to the Engineer, any proposal of providing construction joints to facilitate his work, for the study and approval of the Engineer well in advance.

3.1.8 Ordinary Concrete

Ordinary concrete like lean concrete shall be of nominal mix as per relevant clauses of IS: 456.

3.2 REINFORCEMENT

3.2.1 Bending of Reinforcement

All bars shall be carefully and accurately bent by the Contractor in accordance with approved Drawings and bar bending schedules. Special care shall be taken to ensure correct lengths of laps. The bars shall not be bent or straightened in any manner that will injure the bars or impair the bond between reinforcement & concrete. Bends and hooks are to be provided as laid down in the IS: 2502.

3.2.2 Placing

All reinforcement shall be placed and maintained in the position shown in the drawings. Contractor shall provide approved type of cover blocks to suit the requirement of the Drawings. Where reinforcement is to be provided on two faces of the shell, the Contractor shall provide adequate number of separators, with the approval of the Engineer. Any additional

support to the reinforcing cage, if required at the time of concreting, shall also be provided, to the satisfaction of the Engineer. Lapping of reinforcement as specified in the drawings or as directed by the Engineer, shall be provided. Laps shall be staggered and too many laps shall be avoided. Welded laps shall be provided only when directed or approved by the Engineer.

3.2.3 Fixing of Reinforcement

18 SWG annealed steel wire shall be used as binding wire. Bar crossing one another and contact laps shall be bound with this wire twisted tight to make the skeleton or network rigid so that the reinforcement is not displaced during placing of concrete.

3.3 FORMS

Construction by Slip-form Method

Slip-form construction shall be for construction of the wind shield. Type of Slip-form proposed should be indicated in the offer with sketches, drawings and construction statement as explained hereinafter. Number, type and capacities of jacks, the control system and achievable rate of progress in mm/hour should also be indicated. The chosen scheme shall be of a past proven design. A certified performance record of the scheme should be submitted with the offer to guarantee workability of the scheme both from execution time and safety point of view.

The Tenderer should furnish a brief but comprehensive statement indicating the planning & programme and method of work to be followed, for the approval of Owner at the time of submitting Tender. This statement shall include the following items:

3.3.1 Type and description of Slip-form equipment and its accessories.

3.3.2 Design of scaffolding and staging.

3.3.3 Description of materials including admixtures to be used for construction.

3.3.4 Manpower planning, construction spaces required, standby arrangement.

3.3.5 Rate of Slip-forming.

3.3.6 Proposed workability requirement of concrete and type of cement & admixture to be used.

3.3.7 Quality assurance programme.

3.3.8 Method of Transportation of material

3.3.9 Method of curing and rectification of defects.

3.3.10 Planned interruption, if proposed, and activities during planned interruption. Treatment of construction joint.

3.3.11 Contingency solution for unplanned interruptions.

3.3.12 Time of completion.

While selecting the Contractor, due consideration will be given to the merit of the above mentioned statement proposed by the Tenderer.

Not withstanding what have been specified in earlier clauses, following guide lines are being presented which should be kept in view by intending Tenderers, while quoting for Slip-form method of construction:

(a) Care to be taken to prevent dragging of concrete alongwith upward movement of the shuttering. For this purpose following steps are advisable:

(i) Shutter plates have to be smooth and should be thoroughly clean. Before fixing them in position all the surfaces which will be coming in contact with concrete to have a coat of epoxy paint.

(ii) In areas where concrete thickness is 750 mm or more rate of pouring should be such that minimum slipping of shuttering is 100 mm per hour.

(iii) Mix design should be so done that it will be self- lubricant at the contact face of shutter and concrete and thus reduce friction. Suitable cement of approved manufacturer (conforming to relevant I.S. Specification) may be used for the purpose. An optimum ratio of coarse/fine aggregate should be established to suit the purpose depending on availability of aggregates.

(iv) Mix design also should be so done that it has a slump of 50 mm at the point where concrete is placed under an ambient temperature of around 40 Deg.C. This will also keep vibration by needle vibrators to required minimum. Slump should not by needle vibrators to required minimum. Slump should not drop down to zero in less than 45 minutes. Suitable retarding agent and plasticizer of approved manufacture may be added in mix to achieve this purpose. These admixtures to be properly identified by preliminary tests both for performance and for compatibility with particular type of cement proposed to be used.

Additional steps like spraying of water over the shutters and keeping down the temperature of coarse aggregates by continuous spraying of water over those may be resorted to if ambient temperature is more than 40 Deg.C.

(b) Care must be taken to prevent twist, which predominantly occur in the initial stages because of low slipping rate, in the horizontal plane of Slip-form assembly. A thorough check on this aspect must be kept at every 15 minutes interval. One person should exclusively be assigned this work together with rectifying any defect.

(c) Every endeavour has to be made so as not to occur any tilt in the shutter assembly. To achieve this following steps need be taken:

(i) Performance of jacks has to be closely observed and any defective one needs immediate replacement. Difference in levels of opposite jacks at any instant of time should not exceed 5 mm.

(ii) Loading on Slip-form truss/yokes has to be fairly equal.

(iii) Sleeve through which jacking rod passes has to be of sufficient length so that later gets an uniform clearance and does not get any chance to tilt. Sleeve should have a minimum wall thickness of 3.25 mm and should be such that jacking rod gets a maximum clearance of 1 mm to 1.5 mm all- round.

(d) For taper walled chimneys overlapping of shutters which are kept to effect the tapering, needs careful attention otherwise these may be filled with concrete slurry.

(e) In designing the mix following aspects should be borne in mind :

(i) Cement used should have an initial setting time of not less than 50 minutes

(ii) Coarse and fine aggregates should be well graded and rounded aggregates offer better performance in Slip-form technique. These help to keep down water/cement ratio and also offers better lubrication between concrete and shutter surface. 40 mm down size of coarse aggregates should preferably be used unless reinforcement detailing calls for lesser size aggregates.

(iii) From the point of view of creep, shrinkage as well as initial setting property of concrete, cement content should not preferably be more than 400 Kg. per Cu.M of concrete.

(iv) Minimum compressive strength (after 4 to 6 hours of mixing) of concrete immediately below the shutter as slipform proceeds should be between 0.1 to 0.2 Newton/ Sq.mm.

(v) It is advisable to use cement from a single source during the entire operation of slipform technique since once the system starts, there might not be any time left for conducting trial mixes if the source of procurement of cement changes.

(f) Large diameter vibrator needles should not be used for vibrating concrete. Sizes of these needles should preferably be restricted to 25 mm diameter and to 40 mm diameter - only in exceptional cases. At least two nos. standby vibrator units should always be maintained on top of working deck at all time during the entire period of slipform operation.

(g) It is preferable to have membrane curing compounds sprayed on fresh surfaces emerging out of shutter panels for ensuring proper curinng at great heights.

In case such spraying is not envisaged then elaborate arrangement has to be made for adequate supply of water both on inside and outside vertical surfaces with spraying arrangement, necessary length of pipelines and pump of adequate head to serve the purpose. It is always advisable to have a stand-by pump for effective utilisation of the system.

(h) If Slipforming is carried out in summer, rate of slipping should be around 400 mm per hour. If lesser value is contemplated appropriate retarders should be specified.

(i) Exact number and capacity of jacks as well as spacing of yoke frames are to be determined taking into account various loadings including self weight of the system, dead and live loads on working and other platforms, horizontal load on formwork, wind load etc.

It is desirable that jacking system, based on which the entire slipform system works, should consist of jacks 3 Tonne/ 6 Tonne capacity and a hydraulic pump with necessary pipe connections.

Spacing of yoke legs should preferably be kept within 2 metres to prevent overloading on jacks and consequent failure resulting in twist of the formwork.

Jacking rods should be of 25 mm diameter for 3 Tonne Jacks and 32 mm diameter for 6 Tonne Jacks.

(j) At least 30% spare jacks and jacking rods should be kept ready during the entire operation. It is obligatory to maintain spare hydraulic pump alongwith a set of loose pipes in perfect working condition on top of working deck.

(k) In sections where thickness is 500 mm or more it is prudent to go in for two nos. of jacks for each slipform yoke.

(l) For effective utility of this technique following areas need careful attentions at the very conceptual stage:

(i) Detailed quality assurance programme.

(ii) Advance Planning and preparations.

(iii) Arrangement for on site supervision and adequate access facilities.

(m) Construction methods including description and types of different equipment proposed to be used, structural arrangement and analysis of the system, description and type of different materials, planned interruptions, description and frequency of various checks and tests for Slipform technique as well as for material, method of preparing, transporting and pouring of concrete, solution for probable defects during slipping, sequence of operations during planned interruptions etc. should be prepared beforehand by executing agency and to be approved by Engineer before starting the actual work.

(n) Placing and binding of reinforcement is also a very critical item and needs special attention. From practical considerations not more than two or three layers of horizontal steel can be tied at a time and this causes a definite limitation in placement of reinforcement.

Vertical reinforcements should be kept vertical by providing suitable holders within the slipform system.

(o) It is desirable to have a break of at least one day for every two weeks of continuous operation. Such break should be utilised for various maintenance activities, removal of jack rods etc.

(p) Numbers and locations of hoists for lifting concrete, reinforcement and other materials have to be planned well in advance. Capacity of hoists should be such as to match with hourly requirement of concrete and reinforcement. If felt necessary one hoist may be exclusively earmarked for transporting concrete.

For movement of personnel supervising the work a separate hoist must be arranged for.

(q) The system being operative round the clock it is obligatory to have adequate lighting arrangement both on various platform levels as well as on ground below. Arrangement has to be made for facilitating continuous upward movement of the entire system alongwith slipform.

(r) Winches for lifting men and material and mixers, if located within unsafe area around chimney, should be protected by adequate shelter from possible damage.

(s) Proper tele-communication system has to be established between the personnel working on top of Chimney and control room below.

(t) A small laboratory should be maintained at site for testing different materials like cement, coarse and fine aggregates. A cube testing machine may also be installed at site for getting quick feed back results.

Apart from using plumb bobs, level and theodolite instruments for survey purpose arrangement should also be kept for lasers.

(u) In case of interruption in the course of slipping of formwork following measures should be taken :

(i) Provision of a key and additional reinforcement at the junction of new and old concrete.

(ii) Slipform system should be brought up freely to have a minimum overlap of 100 mm or so over previously cast concrete.

(iii) Washing of old concrete surface with compressed air and water jet and thereafter pouring a layer of neat cement grout.

(iv) Clearing of shuttering panels of loose materials, concrete etc. by compressed air and applying a coat of epoxy paint, if felt necessary by Engineer.

(v) Neatly finishing the interface of old or new concrete as soon as it comes out of shutter panel.

(v) It is preferable to suspend the construction work under high wind condition.

(w) It is of utmost importance that for effective implementation of this system an Engineer fully conversant with Slipform technique with enough experience in planning and control of formwork should be in overall command of the site and he should be ably supported by well trained mid level supervisory staff, skilled workers and operators.

(x) Operation of slipform method of construction is a continuous one and it demands continuous/intermediate inspection of accuracies in line, level, dimensions and position and immediate rectification of any noticed deviation. All these ask for personnel of high quality having constant vigilance over the construction activity.

(y) While all the activities in effective implementation of the work needs utmost care keeping safety of men and material in mind it is obligatory that all activities should be carried out under the guidance of a qualified and trained safety Engineer.

Safety measures as listed below must be adhered to but should not be limited to only these:

(i) Safety helmets and belts to be provided to all supervising staff and workers.

(ii) Safety nets to be provided below both inside and outside atforms as instructed by Engineer.

(iii) Handrailing and toe guard to be provided around all openings and platforms.

(iv) Regular maintenance of equipment, checking of hoists, scaffoldings etc.

(v) Passenger hoist must have multiple ropes with adequate factor of safety.

(vi) Emergency lights, coloured lamps to be provided in accordance with relevant Indian Standards and as supplemented in the Specification and to be operative in case of sudden power failure Emergency standby generator must be kept ready during the entire period of slipform method of construction.

(vii) Emergency vehicles, first aid facilities must be kept ready during the entire period of work.

(z) Permissible construction tolerances should be limited to the following:

(i)	Variation in wall thickness	:	(-) 5 mm, (+) 25 mm
(ii)	Variation from Design Diameter	:	(+_) 25 mm or (+_) 2.5 mm per 3 m dia. Whichever is larger, but in no case more than (+_) 5 mm.

3.4 STEEL FLUES

3.4.1 General

Fabrication and erection of Steel Flues shall conform to "Technical Specification for Fabrication and Erection of Structural Steelworks" furnished in this Specification.

3.4.2 Fabrication

Plates out of which flues will be fabricated, should be bent to the required shape on an appropriate machine. No smithy process shall be adopted for the purpose. Plates are to be prevented from distorting by more than the tolerances specified during transportation, storage, handling, erection and jointing. All components should be correctly located and brought into correct alignment and level within specified erection tolerances, before adjacent pieces are jointed or secured.

3.4.3 Assembly

Flue would be assembled from its Component "Cans" near to ground level within the wind-shield. Incomplete flue would be hung only from the flue support platform during assembly, and progessively hoisted to enable connection of further cans at its lower end. Upon completion of the initial sectional length, this length will be hoisted and supported in its final position at the flue support floor as indicated in the drawing. It is envisaged that flue will be assembled and hoisted in three sectional lengths; site joints between sectional lengthy being located just above a steel floor level.

Joints between individual cans should be flanged and bolted on outside and to have sealed welded joints on inside in accordance with clause 3.3.section-4 "Welded Construction" under Technical Specifications" for Fabrication of structural steel work. The Contractor shall submit a drawing showing proposals for erection and indicating locations of all site joints which should be kept to minimum.

3.4.4 Flue Expansion Compensator

For installation of Expansion Compensators, the manufacturer's instruction should form the basis of the Contractor's method. This method, in a statement, should be submitted to the Engineer for approval. Once approved it has to be followed throughout the installation sequence. Expansion Compensators should be prevented from distortion during

transportation, handling, erection and jointing, by more stringout tolerances than specified by the manufacturer.

3.4.5 Tolerances

Permissible tolerances in the fabrication and erection of steel flues are given below:

(a)	Internal diameter shall not vary by more than	:	± 12 mm
(b)	Centre of any section shall not be eccentric from vertical centre line by more than	:	10 mm in any 15 metre height
(c)	Centre of any section at height 'h' is in mm. above GL shall	:	(h/2500 + 10)mm, not be vertical centre where line by more than

(d) Local deviation from a true circular form should not exceed the shell thickness (Measurement should be made from a segmental circular template having radius of flue shown in drawing and a chord length equal to 0.15 of that radius).

(e) Peaking or stepping at welded horizontal seams shall not exceed 4 mm. (Measurement shall be made with a straight edged template long enough to contact the straight shell on either side of the peaked area).

3.4.6 Erection

Erection of Steel Flues and C.I. Chimney caps shall be done as per requirement of IS: 800. The Contractor shall submit to the Engineer a programme of erection for his approval. All plant, equipment, tools, tackle and any other accessories required for the erection shall be provided by the Contractor. Storing and handling of fabricated materials for erection, setting out of members, providing temporary supports, bracing, fasteners, bolts,

nuts etc. shall be the responsibility of the Contractor and shall be taken into account in quoting the rate.

3.5 INSULATION AND PROTECTIVE TREATMENT

3.5.1 Acid and Heat Resistant Paint

Top 50 meters of the outside face of R.C.C. windshield, horizontal surface at the top of windshield and inside face of the windshield or as specified in the drawing shall receive a protective treatment of four coats of acid and heat resistant black impregnated bitumastic paint. The quality and type of the paint shall have the prior approval of the Engineer. For this, a small area shall be painted and a sample of paint shall be shown to the Engineer.

The surface to be painted shall be prepared and primary coat, if required as per the paint manufacturer's specification and direction of the Engineer, shall be applied. The paint shall conform, unless otherwise stated, to the requirement of IS: 158. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for his approval. The surface to be painted shall be completely dry before the paint is applied and the drying time between consecutive coats shall not be less than 5 hours. The overall combined thickness of paint shall be a minimum of 150 microns.

3.5.2 Synthetic enamel Paint

The outside face of the Chimney shell, unless specified otherwise, shall be painted with Synthetic enamel paint. The quality shall be approved by the Engineer. Necessary samples shall be submitted to the Engineer for his approval. The surface of the shell shall be prepared as per paint manufacturer's specification. In addition, care shall be taken that the surface is free from stain, honey comb and any rough and uneven surface. The joints between two shuttering and two lifts of shuttering shall be so prepared that any uneveness, if by chance exists, shall be removed. If one coat of paint is not sufficient to give the required finish, the Contractor shall repaint the surface, until the Engineer is satisfied with the workmanship. The paint shall conform, unless otherwise stated, to IS: 5410. Necessary samples, test certificates and manufacturer's literature shall be submitted to the Engineer for approval.

3.5.3 Insulation and Packing

All insulation material should be of dimension and type, shown in the drawing. Load bearing insulations at supports and side restraints of Steel liners should be an assembly of M.S. Plates, Stainless Steel Plates, PTFE (Poly Tetra Fluoro Ethylene) sheets and or/asbestos fibre reinforced boards (SINDANYO BLOCKS). Insulation to be fixed on outer surface of steel flues should be made of glass or mineral wool.

(a) Load Bearing Insulation Block

Load bearing assembly should consist of three units and be fabricated according to approved drawings. It would be fabricated from mild steel units with a stainless steel sheet bearing plate and load bearing insulation blocks as indicated in drawing.

The first unit is bolted to the supporting beam. It consists of a M.S. base plate with bolt holes on which a machined M.S. plate is welded. This plate is provided with recess for PTFE sheet (conforming to BS : 5400) to seat, being lubricated with silicon grease.

The second unit also consists of a M.S. plate having adequate size & thickness as shown in drawing. While one surface of the plate is provided with a stainless steel bearing plate the other surface has a thin layer of lead/elastomeric sheet. The side having stainless steel surface is placed on PTFE surface of First unit.

The third unit consists of two layers of load bearing insulation blocks each having a minimum thickness of 50 mm and factory bonded to top & bottom M.S. plates. These are separated by 100 mm. long load bearing insulation dowels as shown in the drawing. These plates are in turn welded to two additional M.S. plates. Of the two surfaces thus created one shall be welded to bracket assembly while the other should rest on the lead sheet of second unit. Bearing assembly, thus formed, should be levelled by using suitable M.S. shims.

Support arrangement typically consists of flue support shoe (a part of flue), flue support bracket connected to the shoe by precision bolted

connection. The bracket in turn is welded to the bearing assembly, which in turn is bolted to available supporting beams.

Support brackets and bearing assembly are welded to locally thickened area of flue. These support the flue on support platform at suitable locations indicated on the drawing.

The arrangement described above should cater for easy and smooth thermal movements of linear element. Suitable restraint brackets and M.S. stop plates need be provided as shown in drawings to prevent excessive movement and thus keeping different units of bearing assembly in proper position.

(b) Insulation Block at Lateral Restraints

At flue restraint platforms, necessary restraint arrangement with load bearing insulation blocks and stainless steel bearing plates fixed to the insulation blocks should be provided as indicated in drawings.

Restraint and support brackets need be provided for the bottom supported portion of the flue which rests on the support platform provided at the base to cater for bearing and restraint requirements.

(c) Glass or Rock Wool

Insulation thickness shall be determine as is specified in clause 2.5.11 Thicker layer shall be put as first layer around the flue on its exterior surface.

The insulation on the flue shall be fixed using chicken G.I. wire mesh, G.I. wire ties, insulation retaining studs, washers etc. All joints shall be staggered. The insulation shall be tightly secured to the exterior surface of the flue by impaling on the studs and fixing in place by means of 63mm round or square metal plated speed washers. 20 gauge galvanized wire netting shall be wrapped continuously over the entire exterior of insulation. The wire mesh shall be 25mm hexagonal pattern conforming to IS:1566. All joints in the mesh shall be tapped a minimum of 150 mm tied by 16 gauge soft annealed wire at 300 mm spacings. Lacing at joints shall not be used. The Contractor

before application of insulation, shall take prior approval of actual fixing arrangement from the Engineer.

The insulation shall be able to sustain structural vibrations and shall not settle under such conditions during erection, construction & operation. The insulation shall be suitably tied to prevent dislocation under adverse conditions.

(d) Vermiculite Concrete

Vermiculite concrete shall be made by mixing exfoliated vermiculite, portland cement and water. It shall be of Grade-B, having a density of 210 Kg./Cu.M. The vermiculite aggregate size shall be maximum 6 mm. The mix shall be 1cement and 8 vermiculite by volume.

3.6 ACID-PROOF/CHEMICAL RESISTANT PROTECTION TO ROOF SLAB

Acid-Proof/Chemical Resistant tiles bedded on acid proof/chemical resistant mortar shall be provided for the protection of roof slab. The intervening space between the tiles shall also be filled up by chemical resistant/acid-proof epoxy mortar grouts. The mortar shall be used immediately after mixing.

Tiles shall be made of clay, feldspar or quartz and vitrified at a high temperature in ceramic kilns. These should be unglazed, free from deleterious materials and should conform to IS: 4457. Iron oxide in the raw materials used, shall not exceed 2 percent. They should show a fine grained, dense and homogenous fracture when broken. They shall be sound, true to shape, flat and free from flaws and other manufacturing defects. Dimensions of the tiles shall be 198.5 x 198.5 x 35 mm. Depth of the groove on the underside shall not be more than 3 mm. Compressive and tensile strengths of the tiles shall not be less than 70 N/Sq.mm and 3.5 N/Sq.mm respectively.

3.7 FLUE ACID DRAINS AND MANHOLES

Flue acid drainage system, where provided, will comprise of collection sumps, dilution manholes, conveying pipes including connection to main drainage system.

Stainless steel pipes, bends, collection sumps, fixing straps, bolts etc. conforming to the relevant Indian Standards (or in absence of which British Standard BS: 3605) shall be used in work. Pipes should be cut and joined as per manufacturer's instructions so as to leave the surface clean and square to the axis of pipe.

Manhole should be constructed as per drawing. However, for general guidance it may be noted that pit of required dimensions should be excavated, lean concrete (1:2:4 mix) of required thickness to be laid, Acid-proof/Chemical resistant brick masonry in 1:4 acid resistant cement mortar of necessary thickness be built and both sides plastered by 12mm thick acid proof plaster (1:3 mix) having waterproof admixtures.

Manholes should be covered by reinforced concrete slab on which a heavy duty (HD) manhole cover with frame having diameter 560mm and total weight 255 Kg (140 Kg for manhole and 115 Kg for cover) is to be fixed. For additional safety another inner cover or other approved methods may be adopted. The manhole cover shall be distinctively coded to indicate the type of drainage involved.

Inside manholes necessary channels and benchings finished smooth by neat cement in cement concrete (1:2:4) and foot rungs made from 20mm round bars at 300mm centres and staggered should be provided. Rungs should project 100mm from wall face and be embedded 200mm inside cement concrete block made in that location of brick work. These foot rests shall be painted with coal tar in the projected portions and cement slurry in the embedded part. Joint of any pipe with brick work shall be rendered perfectly leak proof.

Pipes and fittings in the connection pipe to the main drainage system shall be vitrified clayware conforming to relevant IS and laid to the line and level indicated in the drawings.

3.8 ROOF DRAINAGE

3.8.1 General

Rainwater outlets and down comers to run along inner face of stack wall, shall be made of standard cast iron rainwater pipes conforming to IS:1230.

The brackets used to hold the pipes alongside the walls shall be wrought iron clevis type, split ring type or of perforated strap iron as approved by the Engineer. Each vertical pipe shall hang freely on its bracket fixed just below the socket. Suitable spacer blocks are to be kept in between the pipe and wall surface for fixing the pipe. All bends and junctions shall be provided with water tight clean-outs.

3.8.2 Pipe Joints

All joints between pipes, pipes and fittings and manholes shall be gas-tight when above ground and water tight when under ground. Method of pipe cutting and jointing shall be as per instruction of the pipe and fittings manufacturer or as approved by the Engineer. However following guidelines may be followed in absence of any instruction available from the manufacturer.

Socket and Spigot pipes shall be joined by cast lead joints. Spigot of the following pipe should be centred in the socket of the preceding pipe by tightly caulking in sufficient turns of tarred gasket or hemp yarn to have unfilled half the depth of socket. After the gasket or hemp yarn has been caulked tightly, a jointing ring shall be placed round the barrel and tightened against the face of the socket to prevent air lock. Molten lead shall then be placed round the barrel and tightened against the face of the socket. Thereafter molten lead should be poured in to fill the remainder of the socket and caulked with suitable tools tight round the joint to make up for shrinkage of the molten metal on cooling and should be finished 3mm behind the socket face. If any joint is suspected to be damaged it has to be opened out & redone.

Joints in cast iron pipes with special jointing arrangements like "Tyton" joints etc. shall follow the instructions of the manufacturer.

4.0 TESTING AND ACCEPTANCE CRITERIA

4.1 GENERAL

The Contractor shall carry out all sampling and testing in accordance with the relevant IS Specifications and as supplemented herein, for the following items or any other item as may be required by the Engineer unless otherwise

specified in this specification. The Contractor shall get the specimens tested in laboratory, approved by the Engineer and shall submit to him, the original test results in triplicate, within seven days after the completion of the test. Engineer may present himself while such tests are being carried out.

4.2 CEMENT

Representative samples shall be taken as per the relevant IS Specification from each consignment of Cement received from the Purchaser/ Manufacturer/Supplier for carrying out the tests for fineness (by hand sieving), setting time, compressive strength and soundness tests, and the Contractor shall carry out the above tests as per relevant Indian Standard. If the cement is supplied by the Contractor the test shall be carried out by him. The Contractor shall carry out any or all the tests on aggregates as may be required by the Engineer, in accordance with IS:2386 Parts-I to VIII. The acceptance criteria of the samples tested shall be in accordance with the requirements of the relevant IS specifications.

4.3 WATER

Sampling and testing of water being used for concrete works shall be carried out as per IS: 3550, by the Contractor, at regular intervals and whenever directed by the Engineer. The final acceptance criterion in case of doubt shall be as per IS: 3025.

4.4 CONCRETE

The Contractor shall take cubes for works test as per requirement laid down in IS: 516 regularly from the day's pour. The number of test cubes to be taken shall be as per IS: 456. The Engineer may also use his discretion in deciding the rate of cubes to be taken. The acceptance criteria is to meet the requirement of IS: 456. If the cube test results indicate that some portions of the work is below the required strength, the Engineer may order demolition of that portion of work which is below strength and ask the Contractor to rebuild, provided a satisfactory method of load testing is not possible. Such testing or demolishing and rebuilding shall be carried out by the Contractor.

4.5 STEEL FLUE

All site and shop welded joints shall be inspected and tested in accordance with clause 4.00.00 of Technical specification for Fab. and Erection of structural steel work.

4.6 INSULATIONS

The insulating materials shall be tested for its stipulated characteristics and properties in accordance with the latest editions of IS:3144 and IS:3346 and/or as directed by the Engineer.

5.0 INFORMATION TO BE SUBMITTED

5.1 WITH TENDER

The following technical information are required with the tender:

(a) Source and arrangement of processing of aggregates proposed to be adopted.

(b) Type of plant and equipment proposed to be used.

(c) Names of firms with which association is sought for to execute the special items of work e.g. flue expansion compensator, load bearing insulation blocks etc. in the contract.

(d) Types of formwork proposed to be used. All details as per clause no. 3.03.06 to be submitted, if slip form method is proposed to be used.

(e) Shop proposed for fabrication of steel (flue) liners. Detailed write-up on procedure of erection of complete liner system including details of equipment proposed for the same.

(f) For insulating material tests to be offered for inspection & tests for which test certificates will be submitted. A drawing showing the details of fixing insulation on the flues at bearings, lateral restraints and exterior surface.

(g) Proposal for lifting of men and material in constructing the chimney.

5.2 AFTER AWARD

The following information and data including samples where necessary, shall be submitted by the Contractor, progressively during the execution of the Contract.

5.2.1 Programme of Execution and requirement of Materials

Within 30 days of the award of the Contract, the Contractor will submit a Master Programme for completion of the work giving month wise requirement of materials, particularly mentioning in details the materials which are to be supplied by the Owner and for the procurement of which the help of the Owner is required as per the terms & conditions of the Contract. In case the Contractor proposes to take on hire any machinery or tools and plants from the Owner, the detailed phased out programme of such hire is also to be submitted.

The master programme may have to be reviewed and updated by the Contractor quarterly or at more frequent intervals as may be directed by the Engineer depending on the exigencies of the work.

Detailed day to day programme of every month is to be submitted by the Contractor before the commencement of the month.

5.2.2 Samples

Samples of all materials proposed to be used shall be submitted as directed by the Engineer, in sufficient quantities, for approval. All samples shall be submitted well in advance of starting work at site. Approved samples will be preserved by the Engineer for future reference. The approval of the Engineer shall not, in any way, relieve the Contractor of his responsibility of supplying material of specified quality.

5.2.3 Design Mix

Design mix as per details of this specification giving proportions of ingredients, sources of aggregates and cement along with accompanying test results of trial mixes as per relevant IS Specifications shall be submitted to the Engineer, for his approval, before it can be used on the work.

5.2.4 Detail Drawings

Following items shall be provided by the Contractor which are to be approved by the Owner and Consultant.

(a) Detail drawings and designs of form work including scaffolding to be used. If slipform method of construction is adopted, then detail drawings showing all the arrangements for slipform technique including methods for reducing internal diameter and providing required slopes on outer diameter.

(b) Detail drawings and bar bending schedules for concrete components.

(c) Shop drawings for structural steel and metal work, including inserts etc. The Contractor shall submit his proposal for testing site and shop joints provided in steel members.

(d) Detail drawings for templates and temporary supports for embedments.

(e) Category wise requirements of MS, tor and structural steel including GI flats of various sizes for procurement.

(f) Detailed drawings of steel flues indicating details of joints, supports and restraints including insulation blocks, and details of expansion compensator.

(g) Detailed drawing of hoisting arrangement for men and material satisfying statutory regulations laid down for safety purpose.

5.2.5 Reports

Following Test Reports shall be furnished by the Contractor:

(a) Mill Test Report for cement and reinforcing steel if the materials are supplied by the Contractor.

(b) Inspection Report of bought out items.

(c) Inspection Report of formwork and reinforcement, insulations etc.

(d) Reports of tests of various material and concrete.

(e) Radiographic tests on welded joints in steel flues.

(f) Any other data or report or test result required by the relevant IS Specifications and if required by the Engineer for satisfactory quality control of the workmanship.

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ROADS AND DRAINAGE

CONSULTANT : PROCON ENGINEERS

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ROADS AND DRAINAGE

[PART – A]

CONSULTANT : PROCON ENGINEERS

CONSULTANT : PROCON ENGINEERS

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CLAUSE. NO.	DESCRIPTION
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CONSULTANT : PROCON ENGINEERS

1.0 SCOPE

This specification covers all work required for the construction of road including box-cutting, edging, preparation of sub-base, water bound macadam, bituminous macadam, wearing course etc. excluding toppings and shall include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work. Notwithstanding the provisions of the technical specification, all road works shall be carried out as per IRC / MORT&H specification

This specification also includes all work required for drainage including road side RCC drain, RCC culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.0 GENERAL

2.1 WORK TO BE PROVIDED FOR BY THE CONTRACTOR.

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following:

(a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

(b) Submit for approval detailed schemes of all operations required for executing the work e.g. material handling, placement, services, approaches etc.

(c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.2 WORK TO BE PROVIDED FOR BY OTHERS

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.3 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.

(a) Specification for road and bridge works of Ministry of Road Transport & Highways (Fourth Revision). Published by the IRC, New Delhi-2001.

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

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

(d) IS: 456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

(e) IS: 2212 Code of Practice for Brickwork.

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

(g) IRC: 36 Recommended Practice for Construction of Earthen embankments for Road Works.

(h) IRC: 37 Guidelines for the design of Flexible pavements

(i) Other specifications mentioned elsewhere in this specification.

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

2.4 CONFORMITY WITH DESIGNS

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.5 MATERIALS TO BE USED

2.5.1 General

All materials required for the work shall be of best commercial variety and as approved by the Engineer. Material to be used in the work shall conform to the specifications mentioned on the drawings, the requirements laid down in MORT&H Specification and specification for relevant items of work carried under these specifications.

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2.6 QUALITY CONTROL

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used. All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for road works are described hereinafter

2.6.1 Horizontal Alignments

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

2.6.2 Surface Regularity of Sub grade 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-I.

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 intervals of 10 metres.

2.6.3 Longitudinal Profile

The levels of the sub grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below:

TABLE 1.

TOLERANCES IN SURFACE LEVELS (Table 900-1 of MORT&H)

1.0	Sub grade	+ 20 mm
2.0	Sub-base + 10 mm :	- 25 mm
(a)	Flexible pavement	-20 mm
(b)	Concrete pavement (Dry lean concrete or Rolled concrete)	+6 mm - 10 mm
3.0	Base-course for flexible pavement	
(a)	Bituminous course	+ 6 mm - 6 mm
(b)	Other than bituminous	+ 10 mm
	(i) Machine laid	- 10 mm, + 15 mm
	(ii) Manually laid	- 15 mm
4.0	Wearing course for flexible pavement :	
(a)	Machine laid	+ 6 mm - 6 mm
(b)	Manually laid	+10 mm -10 mm
5.0	Cement concrete pavement	+ 5 mm - 6 mm *

* This may not exceed - 8 mm at 0- 30 cm from the edges.
Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course, if the thickness of the former is thereby reduced by more than 6 mm for flexible pavements and 5 mm for concrete pavements.

For checking compliance with the above requirement for subgrade, sub-base and base courses, measurements of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance.

CONSULTANT : PROCON ENGINEERS

TABLE 2

MAXIMUM PERMITTED NUMBER OF SURFACE IRREGULARITIES

(Table 900-2 of MORT & H)

Sr.No.		**Surfaces of Carriageways and paved shoulders**				**Surfaces of laybys, Service areas and all bituminous base courses**			
	Irregularity	**4mm**		**7mm**		**4mm**		**7mm**	
1.0	Length (m)	300							
2.0		75							
3.0	National Highways/ Expressways*	20	2	9	2	1	40	18	4
4.0	Roads of lower category*	40	18	4	2	60	27	6	3

*Category of each section of road as described in the Contract.

The maximum allowable difference between the road surface and underside of a 3 m straight-edge when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be:

(a) for pavement surface (bituminous and cement concrete) : 3 mm

(b) for bituminous base courses : 6 mm

(c) for granular sub-base/base courses : 8 mm

(d) for sub-bases under concrete pavements : 10 mm

TABLE –3

PERMITTED TOLERANCES OF SURFACE REGULARITY FOR PAVEMENT COURSES

Sr. No.	Type of Construction	Longitudinal Profile with 3 metre straight edge					Cross Profile
		Maximum Permissible undulation mm	Maximum number of undulations permitted in any 300 metres 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
1.0	Earthen subgrade	25	30	-	-	-	15
2.0	Granular subbase	15	-	30	-	-	12
3.0	Water Bound Macadam with oversize metal (40-90 mm size	15	-	30	-	-	12
4.0	Water Bound Macadam with normal size metal (20-50 mm and 40-63mm size), Bituminous Penetration Macadam	12	-	-	30	-	8
5.0	Surface dressing ** (two coat) over WBM (20-50 mm or 40-63 mm size metal), Bituminous pene tration macadam or built-up spray grout	12	-	-	20	-	8

Sr. No.	Type of Construction	Longitudinal Profile with 3 metre straight edge					Cross Profile
		Maximum Permissible undulation mm	Maximum number of undulations permitted in any 300 metres length exceeding mm				Maximum permissible variation from specified profile under camber template. mm
			18	12	10	6	
6.0	Open graded premix carpet mixseal surfacing	10	-	-	-	30	6
7.0	Bituminous macadam	10	-	-	-	20***	6
8.0	Semi-dense carpet	10	-	-	-	20***	6
9.0	Asphaltic Concrete	8	-	-	-	10***	4

NOTES :

1.0 **For surface dressing in all other cases, the standards of surface evenness will be the same as those for the surface receiving the surface dressing.

2.0 *** These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Engineer. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

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

2.7 RECTIFICATION

Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

2.7.1 Subgrade: Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirements of Clause 305 of MORT&H.

2.7.2 Granular sub-base: Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the requirements of Clause 401 of MORT&H.

2.7.3 Water Bound Macadam/Wet Mix Macadam Sub-base/Base: Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted to Clause 404. This shall also apply to wet mix macadam to Clause 406 of MORT&H.

2.7.4 Bituminous Constructions: For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat if needed and recompacting to specifications. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 m in length and not less that 3.5 m in width.

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.

2.8 QUALITY CONTROL TESTS DURING CONSTRUCTION

As per Clause 903 of MORT&H specification.

3.0 EXECUTION

3.1 SHOULDER CONSTRUCTION

3.1.1 Description

This work shall consist of constructing shoulders on either side of the pavement, in accordance with the requirements of this specification and in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer.

3.1.2 Materials

Shoulder may be of selected earth or grannlar material conforming to the requirements of (MORTH&H specification) embankment construction or granular sub-base construction respectively.

3.1.3 Construction Operations

Shoulder

The sequence of operations shall be such that the construction of paved shoulder is done in layers each matching the thickness of adjoining pavement layer. Only after a layer of pavement and corresponding layers in paved and earth shoulder portion have been laid and compacted, the construction of next layer of pavement and shoulder shall be taken up.

Where the materials in adjacent layers are different, these shall be laid together and the pavement layer shall be compacted first. The corresponding layer in paved shoulder portion shall be compacted thereafter, which shall be followed by compaction of earth shoulder layer. The adjacent layers having same material shall be laid and compacted together.

Compaction requirement of earthen shoulder shall be as per latest MORT&H specification. In the case of bituminous course, work on shoulder (earthen/hard/paved), shall start only after the pavement course has been laid and compacted.

During all stages of shoulder (earthen/hard/paved) construction, the required crossfall shall be maintained to drain off surface water.

Regardless of the method of laying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement, and the area so affected thoroughly cleaned.

3.2 KERB

3.2.1 Material

Kerb, if required for construction of footpath, shall consist of precast concrete blocks with a concrete grade of M-15. The blocks shall be 100 mm wide and of suitable length. The depth of blocks unless otherwise mentioned elsewhere, shall be 375 mm considering 225 mm height of footpath from the road level.

3.2.2 Laying

The Kerb shall be laid by cutting trenches 150 mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the Kerbs shall be in plumb and the gap between the block shall not be more than 10 mm.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.3 SUB-BASE (GRANULAR SUB-BASE)

3.3.1 Description

This work shall consist of laying and compacting well-graded material on prepared sub grad 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.

3.3.2 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents and conform to one of the three gradings given in Table 4.

While the gradings in Table 4 are in respect of close-graded granular sub-base materials, one each for maximum particle size of 75 mm, 53 mm and 26.5 mm, the corresponding gradings for the coarse-graded materials for each of the three maximum particle sizes are given at Table 5. The grading to be adopted for a project shall be as specified in the Contract.

TABLE 4

GRADING FOR CLOSE-GRADED GRANULAR SUB-BASE MATERIALS

(TABLE 400-1 of MORT&H)

Sr. No.	IS Sieve	Per cent by weight passing the IS sieve		
	Designation	Grading I	Grading II	Grading III
1.0	75.0 mm	100	-	-
2.0	53.0 mm	80-100	100	-
3.0	26.5 mm	55-90	70-100	100
4.0	9.50 mm	35-65	50-80	65-95
5.0	4.75 mm	25-55	40-65	50-80
6.0	2.36 mm	20-40	30-50	40-65
7.0	0.425 mm	10-25	15-25	20-35
8.0	0.075 mm	3-10	3-10	3-10
9.0	CBR Value (Minimum)	30	25	20

Note :

1. The material passing 425 micron (0.425 mm) sieve for all the three gradings when tested according to IS : 2720 (Part 5) shall have liquid limit and plasticity index not more than 25 and 6 percent respectively.

3.3.3 Physical Requirements

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

The material shall have a 10 per cent fines value of 50 kN or more (for sample in soaked condition) when tested in compliance with BS: 812 (Part III). The water absorption value of the coarse aggregate shall be determined as per IS: 2386 (Part 3); if this value is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS: 383. For Grading II and III materials, the CBR shall be determined at the density and moisture content likely to be developed in equilibrium conditions which be taken as being the density relating to a uniform air voids content of 5 percent

3.3.4 Spreading and Compacting

Immediately prior to the laying of sub-base, the sub grade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary, and rolled with one pass of 8-10 tonne smooth wheeled roller.

The sub-base material shall be spread on the subgrade 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 consolidation does not exceed 150 mm.
The sub-base material of grading specified in the Contract shall be spread on the prepared subgrade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation or other means as approved by the Engineer.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations, as in small-sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved

equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the loose material shall be checked in accordance with IS:2720 (Part II) and suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS:2720 (Part VIII). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 95% of the maximum dry density for the material determined as per IS:2720 (Part VII). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction plant and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re- compacted.

3.4 WATER BOUND MACADAM SUB-BASE/BASE COURSE

3.4.1 Description

Water bound macadam shall consist of clean, crushed aggregates mechanically interlocked by rolling,, and bonded together with screenings, binding material, where necessary and water, laid on a prepared subgrade

or sub-base, as the case may be, and finished in accordance with the requirements of MORT&H Specifications and in conformity with the lines, grades and cross-sections shown on the drawings or otherwise directed by the Engineer.

3.4.2 Materials

(a) Coarse Aggregates

Coarse aggregates shall be either crushed or broken stone, crushed slag, overburnt (Jhama) brick aggregates or any other naturally occurring aggregates such as kankar and laterite of suitable quantity. The aggregates shall conform to the physical requirements set forth in Table 5.

TABLE 5 (Table 400-6 of MORT&H)

PHYSICAL REQUIREMENTS OF COARSE AGGREGATES FOR WATER BOUND MACADAM FOR SUB-BASE/BASE COURSES

Sr. No.	Test	Test Method	Requirements
1.0	* Los Angeles Abrasion value OR * Aggregate Impact value	IS : 2386 (part – 4) IS : 2386 (part-4) or IS : 5640**	40 per cent (Max) 30 per cent (Max)
2.0	Combined Flakiness and Elongation Indices (Total) ***	IS : 2386 (Part-1)	30 per cent (Max)

* Aggregate may satisfy requirements of either of the two tests.

** Aggregates like brick metal, kankar, laterite etc. which get softened in presence of water shall be tested for Impact value under wet conditions in accordance with IS : 5640.

*** The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

(b) Crushed or Broken Stone

Crushed or broken stone shall be hard, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt and other objectionable matter.

(c) Grading Requirements of Coarse Aggregates

The coarse aggregates shall conform to one of the gradings given in Table 6, provided, however, the use of Grading No. 1 shall be restricted to sub-base courses only.

TABLE 6 (Table 400-8 of MORT&H)

GRADING REQUIREMENTS OF COARSE AGGREGATES

Grading No.	Size Range	IS Sieve Designation	Per cent by weight passing
1.0	90 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-60
		45 mm	0-15
		22.4 mm	0-5
2.0	63 mm to 45 mm	125 mm	100
		90 mm	90-100
		63 mm	25-75
		45 mm	0-15
		22.4 mm	0-5
3.0	53 mm to 22.4 mm	63 mm	100
		53 mm	95-100

		45 mm	65-90
		22.4 mm	0-10
		11.2	0-5
	Note : The compacted thickness for a layer with Grading 1 shall be 100 mm while for layer with other Grading e.g. 2 & 3, it shall be 75 mm.		

(d) Screenings

Screenings to fill voids in the coarse aggregate shall generally consist of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than rounded river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

Screenings shall conform to the grading set forth in Table7.

TABLE 7

GRADINGS FOR SCREENINGS (Table 400-8 of MORT&H)

Grading Classification	Size of Screenings	IS Sieve Designation	Per cent by weight passing the IS Sieve
A	13.2 mm	12.2 mm	100
		11.2 mm	95-100
		5.6 mm	15.35
		180 micron	0-10
B	11.2 mm	11.2 mm	100
		5.6 mm	90-100
		180 micron	15.35

(e) Binding Material

Binding material to be used for water bound macadam as a filter material meant for preventing ravelling, shall comprise of a suitable material approved by the Engineer having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS : 2720 (Part-5).

The quantity of binding material where it is to be used, will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06-0.09 m3/10m2 and 0.08-0.10m3/10m2 for 100 mm compacted thickness.

The above mentioned quantities should be taken as a guide only, for estimation of quantities for construction etc.

Application of binding materials may not be necessary when the screenings used are of crushable type such as moorum or gravel.

3.4.3 Construction Operations

(a) Preparation of Base

The sub-grade/sub-base to receive the water bound macadam coarse shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained if necessary by sprinkling water.

(b) Inverted Choke

If the water bound macadam is to be laid directly over the subgrade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) shall be spread on the prepared subgrade before application of the coarse aggregates is taken up.

(c) Spreading Coarse Aggregate

The coarse aggregates shall be spread uniformly upon the prepared surface in such quantities that the thickness of the compacted layer is 100 mm for grading 1 and 75-100 mm for gradings 2 and 3 for each layer.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted base be permitted.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall not normally be spread more than 3 days in advance of the subsequent construction operations.

(d) Rolling

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 80 to 100 kN capacity or tandem or vibratory rollers of approved type. The weight of the roller shall depend upon the type of the aggregate and be indicated by the Engineer.

Except on super elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inwards parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width.

Rolling shall continue until the aggregates are thoroughly keyed and the creeping of aggregates ahead of the roller is no longer visible. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base course.

The rolled surface shall be checked transversely and longitudinally with templates and any irregularities corrected by loosening the surface, adding or removing necessary amounts of aggregate and re-rolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to make up depressions.

(e) Applications of Screenings

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanical spreaders, or directly from trucks. Trucks operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand-brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

(f) Sprinkling and Grouting

After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly.

The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well-bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the base or subgrade does not get damaged due to the addition of excessive quantities of water during construction.

(g) Application of Binding Material

After the application of screenings, the binding material where it is required to be used shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms, or mechanical brooms to fill the voids properly, and rolled during which water shall be applied to the wheels of the rollers if necessary to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

(h) Setting and Drying

After the final compaction of water bound macadam course, the road shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer shall have the discretion to stop hauling traffic from using the completed

water bound macadam course if in his opinion it would cause excessive damage to the surface.

3.5 TACK COAT

3.5.1 Description

The work shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to another bituminous construction.

3.5.2 Materials

Binder : The binder used for tack coat shall be bitumen of a suitable grade as directed by the Engineer and conforming to IS:73, 217 or 454, IS: 8887 of a type and grade as specified in the Contract or as directed by the Engineer as applicable, or any other approved cutback.

3.5.3 Construction Operations

3.5.3.1 Preparation of Base

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt and any extraneous material. Immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom and high pressure air jet, or by other means as directed by the Engineer.

3.5.3.2 Application of Binder

Binder shall be heated to the temperature appropriate to the grade of bitumen used and approved by the Engineer and sprayed on the base at the rate specified below. The rate of spread in terms of straight-run bitumen shall be 5 kg. per 10 square metre area for an existing bitumen treated surface and 10 kg per 10 square metre area for an untreated water bound macadam surface. The binder shall be supplied uniformly with the aid of sprayers.

The application of tack coat shall be at the rate specified in the Contract, and shall be applied uniformly. The normal range of spraying temperature for a bituminous emulsion shall be 20 degree Celsius - 70 degree Celsius and for a cutback 50 degree Celsius – 80 degree Celsius if RC-70/MC-70 grade is used. The method of application of the tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar, and speed of forward movement. The contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

The tack coat shall be applied just ahead of the on-coming bituminous construction.

3.6 BITUMINOUS MACADAM BINDER COURSE

3.6.1 Description

This work shall consist of construction, in a single course, of 75 mm thickness of compacted crushed aggregates premixed with a bituminous binder, laid immediately after mixing, on a base prepared previously in accordance with the requirements of these Specifications, and in conformity with the lines, grades and cross sections shown on the drawings or directed by the Engineer.

3.6.2 Materials

3.6.2.1 Binder

The Binder shall be straight run bitumen of a suitable grade as directed by the Engineer complying with IS: 73.

3.6.2.2 Aggregates

The aggregates shall consist of crushed stone, crushed gravel (shingle) or other stones. They shall be clean, strong, durable, of fairly cubical shape and free of disintegrated pieces, organic and other deleterious matter, and adherent coats. The aggregates shall preferably be hydrophobic and of low porosity.

The aggregates shall satisfy the physical requirements set forth in Table-8

TABLE-8

PHYSICAL REQUIREMENTS OF AGGREGATES OF BITUMINOUS MACADAM

Sr. No	Test	Test method	Requirements	
1.0	Los Angeles Abrasion * Value	IS:2386 (Part IV)	35% Maximum	
2.0	Aggregate Impact Value *	-do-	30%	"
3.0	Flakiness Index	IS:2386 (Part I)	35%	"
4.0	Stripping Value	IS:6241	25%	"
5.0	Water Absorption	IS:2386 (Part III)	2%	"

Aggregates may satisfy requirements of either of the two tests. The aggregates for bituminous macadam for different thicknesses shall conform to the grading A or B given in Tables 9 & 10.

TABLE-9

AGGREGATES GRADING FOR 75 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sr. No.	Sieve Designation	Percent by weight passing the sieve	
		Grading A	Grading B
(a)	63 mm	100	
(b)	50 mm	90-100	
(c)	40 mm	35-65	100
(d)	25 mm	20-40	70-100
(e)	20 mm	-	50-80
(f)	12.5 mm	5-20	-
(g)	4.75 mm	-	10-30
(h)	2.36 mm	-	5-20
(i)	75 micron	0-5	0-4

TABLE 10

AGGREGATES GRADING FOR 75 MM COMPACTED THICKNESS OF BITUMINOUS MACADAM

Sr. No.	Sieve Designation	Percent by weight passing the sieve	
		Grading A	Grading B
(a)	50 mm	100	
(b)	40 mm	90-100	
(c)	25 mm	50-80	100
(d)	20 mm	-	70-100
(e)	12.5 mm	10-30	-
(f)	10 mm	-	35-60
(g)	4.75 mm	-	10-30
(h)	2.36 mm	-	5-20
(i)	75 micron	0-5	0-4

3.6.2.3 Fine aggregates

Fine aggregates shall consist of crushed or naturally occurring material, or a combination of the two, passing 2.36 mm sieve and retained on 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter

Fine aggregates shall consist of crushed or naturally occurring material, or a combination of the two, passing 2.36 mm sieve and retained on 75 micron sieve. They shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter

3.6.2.4 Proportioning of Materials

The binder content for premixing shall be 3.5 and 4.0 percent by weight of the total mix for aggregate grading A and B respectively, except when otherwise directed by the Engineer.
The quantities of aggregates to be used shall be sufficient to yield the specified thickness after compaction.

3.6.2.5 Variation in Proportioning of Materials

The Contractor shall have the responsibility for ensuring proper proportioning of materials and producing a uniform mix. A variation in binder content of 0.3 percent by weight of total mix shall, however, be permissible for individual specimens taken for quality control tests.

3.6.3 Construction Operations

3.6.3.1 Weather and Seasonal Limitations

Bituminous macadam shall not be laid during rainy weather or when the base course is damp or wet.

3.6.3.2 Preparation of Base

The base on which bituminous macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross sections as

directed by the Engineer. The surface shall be thoroughly swept and scraped clean and free from dust and foreign matter.

3.6.3.3 Tack Coat

A tack coat shall be applied over the base.

3.6.3.4 Preparation and Transport of Mix

Hot mix plant of adequate capacity shall be used for preparing the mix.

The temperature of binder at the time of mixing shall be in the range 150 Deg.- 165 Deg.C and that of aggregates in the range 125 Deg. - 150 Deg.C, provided that the difference in temperature between the binder and aggregate at no time exceeds 25 Deg.C.

Mixing shall be thorough to ensure that a homogenous mixture is obtained in which all particles of the aggregates are coated uniformly.

The mixture shall be transported from the mixing plant to the point of use in suitable vehicles. The vehicles employed for transport shall be clean and be covered over in transit if so directed by the Engineer.

3.6.3.5 Spreading

The mix shall be spread immediately after mixing by means of a self propelled mechanical paver with suitable screeds capable of spreading, tamping and finishing the mix to the specified lines, grade and cross sections. However, in restricted locations and in narrow widths, where the available plants cannot operate in the opinion of the Engineer, he may permit manual laying of the mix.

The temperature of mix at the time of laying shall be in the range 110 Deg. - 135 Deg.C.

In multilayer construction, the longitudinal joint in one layer shall offset that in the layer below by about 150 mm. However, the joint in the topmost layer shall be at the centre line of the pavement.

Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

3.6.3.6 Rolling

After the spreading of mix, rolling shall be done by 8 to 10 tonne power rollers or other approved plant. Rolling should start as soon as possible after the material has been spread. Rolling shall be done with care to keep from unduly roughening the pavement surface.

Rolling of the longitudinal joint shall be done immediately behind the paving operation. After this, the 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.

The initial or breakdown rolling shall be done as soon as it is possible to roll the mixture without cracking the surface or having the mix pick up on the roller wheels. The second or inter mediate rolling shall follow the break down rolling as closely as possible and be done while the paving mix is still at a temperature that will result in maximum density. The final rolling shall be done while the material is still workable enough for removal of roller marks.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding fresh material. The rolling shall then be continued till the entire surface has been rolled to compaction, there is no crushing of aggregate and all roller marks have been eliminated. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller wheels shall be kept damp if necessary to avoid the bituminous material from sticking to the wheels and being picked up. In no case shall fuel lubricating oil be used for this purpose.
Rolling operations shall be completed in every respect before the temperature of the mix falls below 80 Deg.C.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby. The edges along and transverse of the bituminous macadam laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

The bituminous macadam shall be provided with final surfacing without any delay. If there is to be any delay, the course shall be covered by a seal coat before allowing any traffic over it.

3.7 OPEN-GRADED PREMIX CARPET

3.7.1 Description

This work shall consist of laying and compacting an open-graded carpet of 2 cm thickness in a single course composed of suitable small sized aggregates premixed with a bituminous binder on a previously prepared base, to form a wearing course, in accordance with the requirements of these specifications.

3.7.2 Materials

3.7.2.1 Binder

The binder shall be bitumen of a suitable grade, as directed by the Engineer, and satisfying the requirements of IS:73, 217, 454 or other approved cutback as applicable.

3.7.2.2 Aggregates

The aggregates shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be obtained by crushing rock, gravel or river shingle and be free of elongated and flaky pieces, soft and disintegrated materials, and vegetable or other deleterious matter. They shall preferably be hydrophobic type.
The aggregates shall satisfy the quality requirements set forth in Table 8 except that the Flakiness Index shall be limited to a maximum of 30.

3.7.2.3 Proportioning of Materials

TABLE-11

QUANTITIES OF MATERIALS REQUIRED FOR 10 SQ.M OF ROAD SURFACE FOR 2 CM THICK OPEN-GRADED PREMIX CARPET

Sr. No.		
1.0	Aggregates of Carpet	
	(a) Stone chippings - 12 mm size; passing 20 mm sieve and retained on 10 mm sieve	0.18 Cu.m
	(b) Stone chippings - 10 mm size; passing 12.5 mm sieve and retained on 6.3 mm sieve	0.09 Cu.m
		Total : 0.27 Cu.m
2.0	Binder for premixing (quantities in terms of straight run bitumen	
	(a) For 0.18 Cu.m of 12 mm size stone chippings at 52 kg per Cu.m.	9.5 kg
	(b) For 0.09 Cu.m of 10 mm size stone chippings at 56 kg per Cu.m	5.1 kg
		Total: 14.6 Kg.

3.7.3 Construction Operation

3.7.3.1 Weather and Seasonal Limitations

Open-graded premix carpet shall not be laid during rainy weather or when the base course is damp or wet or when the atmospheric temperature in shade is 16 Deg.C or below.

3.7.3.2 Preparation of Base

The underlying base on which the bituminous carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section in accordance with Table I as directed by the Engineer. The surface shall be well cleaned by removing caked earth and other foreign matter with wire brushes, sweeping with brooms and finally dusting with sacks as necessary.

3.7.3.3 Tack Coat

A tack coat complying with clause 3.5 shall be applied over the base preparatory to laying of the carpet. Application of tack coat shall, however, not be necessary when the laying of carpet follows soon after the provision of a bituminous course.

3.7.3.4 Preparation of Premix

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer, in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably heated to a temperature as directed by the Engineer before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified.

The mixing of binder with chippings shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed.

3.7.3.5 Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader, without any undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid rolling shall commence with 6 to 8 tonne power rollers, preferably of smooth wheel tandem type, or other approved plant. Rolling shall begin at the edges and progress toward the centre longitudinally, except that on the super elevated portions it shall progress from the lower to upper edge parallel to the centre line of the pavement

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rollers shall not stand on newly laid material while there is a risk that it will be deformed thereby.

The edges along and transverse of the carpet laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

3.7.3.6 Seal Coat

A seal coat conforming to clause 3.8 shall be applied to the surface

immediately after laying the carpet. No traffic shall be allowed on the road till the seal coat has been placed.

3.8 SEAL COAT

3.8.1 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:

Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stonee chippings.

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

3.8.2 Materials

3.8.2.1 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 binder to be utilised, in terms of straight run bitumen shall be 9.8 kg and 6.8 kg per 10 square metre area for Type A and Type B seal coat respectively.

3.8.2.2 Stone Chippings for Type A Seal Coat

The stone chippings shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They shall be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matter. Stone chippings shall be of 6 mm size defined as 100 percent passing through 10 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic metre per 10 square metre

area. The chippings shall satisfy the quality requirements spelled out in Table VI except that the upper limit for flakiness Index shall be 30.

3.8.2.3 Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material, organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metre per 10 square metre area.

3.8.3 Construction Operations

3.8.3.1 Preparation of Base

The seal cost 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.

3.8.3.2 Construction of Type A Seal Coat

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer and sprayed on the dry surface in a uniform manner preferably with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

Immediately after the application of binder, stone chippings in a dry and clean state, shall be spread uniformly on the surface, preferably by means of a mechanical gritter, otherwise manually so as to cover the surface completely. If necessary, the surface shall be broomed to ensure uniform spread of chippings.

Immediately after the application of the cover material, the entire surface shall be rolled with a 8-10 tonne smooth wheeled roller. Rolling shall commence at the edges and progress towards the centre except in super elevated portions where it shall proceed from the inner edge to

the outer. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. While rolling is in progress additional chippings shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly bedded in the binder and present a uniform closed surface.

3.8.3.3 Construction of Type B Seal Coat

Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated in boilers of suitable design, to the temperature appropriate to the grade of bitumen approved by the Engineer. Also the aggregates shall be dry and suitably heated to a temperature 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 6-8 tonne 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.

3.8.4 Opening to Traffic

In the case of Type B Seal coat, traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. However, as regards Type a seal coat, traffic shall not be permitted until the following day.

3.9 REPAIR OF EXISTING WATER BOUND MACADAM SURFACE

Pot holes or patches and ruts in water bound macadam base or surface course, which is to be surface treated, shall be repaired by removal of all

loose material by cutting in rectangular patches and replacing with suitable materials. The repair shall be done as under :

Pot holes, patches and ruts shall be drained of water and cut to regular shape with vertical sides, and then be filled either with i) coarse aggregate and screenings conforming to the specification for water bound macadam and compacted with rollers or other approved rammer or ii) premixed material conforming to the specification for open graded premix carpet and compacted with rollers or other approved means after painting the sides and bottom of the holes with a thin application of bitumen or a combination of both as directed by the Engineer.

The above is only applicable in case of damage to the existing water bound macadam surfaces. In case, however, it is found that there has been damage to the granular sub-base as well, the area of the damaged surface shall be repaired by removal of all loose materials, cut to regular shape with vertical sides and re-laid with graded material as per specification of granular sub-base and then surfaced with water bound macadam as per specification for the same.

3.10 BITUMINOUS CONCRETE

3.10.1 Scope

This clause specifies the construction of bituminous concrete, for use in wearing and profile corrective courses. This work shall consist of construction in a single or multiple layers of bituminous concrete on a previously prepared bituminous bound surface. A single layer shall be 25 mm to 100 mm in thickness.

3.10.2 Materials

(a) Bitumen

The bitumen shall be paving bitumen of penetration grade complying with Indian Standard Specification for Paving Bitumen. IS:73 and of the penetration indicated in Table 500-18 of MORT&H, for bituminous concrete or this bitumen as modified by one of the methods specified in clause 521 of MORT&H, or as otherwise

specified in the contract. Guidance on the selection of an appropriate grade of bitumen is given in The Manual for Construction and Supervision of Bituminous Works.

(b) Coarse Aggregates

The coarse aggregates shall be generally as specified in clause 507.2.2 of MORT&H, except that the aggregates shall satisfy the physical requirements of Table 500-17 of MORT&H.

(c) Fine Aggregates

The fine aggregates shall be all as specified in clause 507.2.3 of MORT&H.

(d) Filler

Filler shall be generally as specified in clause 507.2.4 of MORT&H. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-17 of MORT&H then 2 percent by total weight of aggregate, of hydrated lime shall be added without additional cost.

(e) Aggregate grading and binder content

When tested in accordance with IS:2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall

Within the limits shown in Table 500-18 of MORT&H for gradings 1 or 2 as specified in the Contract.

3.10.3 Mixture Design

(a) Requirements for the mixture

Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 500-19 of MORT&H.

The requirements for minimum percent voids in mineral aggregate (VMA) are set out in Table 500-12 of MORT&H.

(b) Binder content

The binder content shall be optimised to achieve the requirements of the mixture Set out in Table 500-19 of MORT&H and the traffic volume as specified in the Contract. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2, replacing the aggregates retained on the 26.5 mm sieve and retained on the 22.4 mm sieve, where approved by the Engineer.

(c) Job mix formula

The procedure for formulating the job mix formula shall be generally as specified in clause 507.3.3 of MORT&H and the results of tests enumerated in Table 500-19 of MORT&H as obtained by the Contractors.

(d) Plant trials-permissible variation in job mix formula

The requirements for plant trials shall be all as specified in clause 507.3.3 of MORT&H and the results of tests enumerated in Table 500-19 as obtained by the contractors.

(e) Laying trials

The requirements for plant trials shall be all as specified in clause 507.3.5 of MORT&H.

3.10.4 Construction Operations

(a) Weather and seasonal limitations

The provisions of clause 501.5.1 of MORT&H shall apply.

(b) Preparation of base

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with clauses 501 and 902 of MORT&H as appropriate, or as directed by the engineer. The surface shall be thoroughly swept clean by mechanical broom and dust removed by compressed air. In locations where a mechanical broom cannot access, other approved methods shall be used as directed by the engineer.

(c) Tack coat

Where specified in the Contract, or otherwise required by the Engineer, a tack coat shall be applied in accordance with the requirements of clause 503 of MORT&H.

(d) Mixing and transportation of the mixture

The provisions as specified in clauses 501.3 and 501.5.4 of MORT&H shall apply.

(e) Spreading

The general provisions of clauses 501.5.3 and 501.5.4 of MORT&H shall apply.

(f) Rolling

The general provisions of clauses 501.6 and 501.7 of MORT&H shall apply, as modified by the approved laying trials.

3.10.5 Opening to traffic

The newly laid surface shall not be open to traffic for at least 24 hours after laying and the completion of compaction, without the express approval of the engineer in writing.

3.10.6 Surface finish and Quality control

The surface finish of the completed construction shall conform to the requirements of clause 902 of MORT&H. All materials and workmanship shall comply with the provisions set out in section 900 of this specification.

3.10.7 Arrangements for traffic

During the period of construction, arrangements for traffic shall bemade in accordance with the provisions of clause 112 of MORT&H.

3.11 ROAD SIDE DRAINS

3.11.1 Formation of Drains

The road side drains shall be made in sizes and slopes as shown on drawings and/or as instructed by the Engineer. The minimum side slope shall be as instructed by the Engineer. The sides and bottom shall be neatly dressed after excavation. Proper connections shall be made to the culverts, outside plant area, as per instructions of the Engineer.

The excavated spoils shall be transported and filled in low areas within the plant area or in embankments as instructed by the Engineer. The lining for the drains shall be as per Dwg. and as mentioned in the Schedule of items. Lining of drains may be of bricks or cement concrete blocks of M15 grade concrete as shown on drawing or as directed by the Engineer. If instructed by the Engineer or shown on drawing, drains may be of R.C.C. construction with necessary slopes.

3.12 CULVERTS

Excavation in trenches for foundation of culverts and wing walls shall be done with side slopes as per the instructions of Engineer after clearing the site, etc. as per specifications of earthwork. Backfilling with ramming and watering shall be done after construction of the foundations.

The construction of culverts shall be done true to lines and levels and as shown on the drawing. The specification for Masonry and/or Plain and Reinforced Cement concrete shall be followed, as applicable.

3.13 PIPE CULVERTS AND DRAINAGE PIPES

3.13.1 Materials

The drainage pipes unless otherwise shown on drawings or instructed by the Engineer shall be made of R.C.C. and shall be either Class NP2 or NP3.

Pipe culverts shall be made of reinforced concrete pipe and shall be of class NP3 or of RDSO class for railway as decided by the Engineer or shown in the drawing. All pipes shall meet the requirements of IS: 458- Latest edition and shall be procured from approved manufacturers with collars as per manufacturer's standard specifications. The tendered shall specifically mention the particular manufacturer's product he proposes to use.

Cement shall be ordinary Portland Cement as per IS:269,8112 - Latest edition.

Aggregates shall be as per IS:383 - Latest edition - Maximum size shall not exceed one third the thickness of the pipe or 20 mm whichever is smaller. Fine aggregates for concrete shall be as per IS: 383 - Latest edition.

3.13.2 Laying of Pipes

Laying of concrete pipes shall correspond to IS:783 - Latest edition – and to specification given below:

(a) The foundation bed for pipe shall be excavated true to lines and grades shown on the drawings or as directed by the Engineer. When trenching is involved its width on either side of the pipe shall not be less than 150 mm nor more than one-third the diameter of pipe unless otherwise instructed/permitted by the Engineer. The sides of the trench shall be as nearly vertical as possible. Side slope, shoring, bailing out water, etc. as required shall be done by the Contractor without the Owner. Side slips, if there be any, shall be removed by the Contractor. After laying of the pipes are completed, backfilling of the trenches shall be done in 250 mm layers, measured loose, clods and lumps broken, watered and compacted with iron rammers to the satisfaction of the Engineer. The surplus

spoils shall be transported and filled in low areas within the plant area, as instructed by the Engineer.

When bed-rock or boulder strata are encountered, excavation shall be taken down to at least 200 mm below the bottom level of the pipe with prior permission of the Engineer and all rock/boulders in the area shall be removed and space filled with approved earth free from stone or fragmented material, shaped to the requirements and thoroughly compacted to provide adequate support for the pipe.

Filling of trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressures do not occur.

When two or more pipes are to be laid adjacent to each other, they shall be separated by a distance equal to at least half the diameter of the pipe subject to a minimum of 450 mm.

Laying of pipes shall start from the outlet and proceed towards inlet.

All pipes and fittings shall be gradually lowered into the trench or placed on the supports by approved means taking due care not to damage them. Under no circumstances the pipes shall be dropped into the trench or on supports from a height.

(b) Pipe bedding shall be first class projection bedding for positive projecting pipes as per IS:783 - Latest edition -having a projection ratio of not greater than 0.70, in which the pipe is carefully bedded on fine granular materials in an earth foundation carefully shaped to fit the lower part of the pipe exterior for at least ten percent of its overall height, and in which earth filling material is thoroughly rammed and tamped in layers not exceeding 15 cm in depth around the pipe for the remainder of the lower 30 percent of its height.

If the pipe is laid in trench, pipe bedding shall be first class bedding as per IS:783.

When indicated on the drawings or directed by the Engineer, the pipe shall be bedded on a craddle constructed of concrete having a

mix not leaner than M15. The shape and dimension of the cradle shall be as indicated on the drawing or directed by the Engineer. The pipe shall be laid on the concrete bedding before the concrete has set.

(c) The drop walls shall be made with first class brickwork in 1:4cement mortar.

(d) The pipe culverts shall be made with proper care regarding the invert of the pipe, gradient, if any, etc. as specified on drawings and/or as instructed by the Engineer.

(e) Where R.C.C. pipes are encased in concrete at road crossings or at other places the pipes need be suitably supported avoiding reinforcements of concrete blocks, joints properly done before concreting is taken up. Concreting of total height of block may be done in a single operation or may be done up to some height for pipes to be properly laid in position and remaining height of block to be concreted subsequently.

(f) The R.C.C. pipes shall be joined with cement mortar. Cement mortar shall consist of 1 part cement and 2 parts of clean sand with only enough water for workability. Procedure of jointing shall be as per IS: 783 - latest edition.

3.13.3 Relation with Water Supply Pipeline

Unless specifically cleared by the Engineer, under no circumstances shall drainage pipes be allowed to come close to water supply pipelines.

3.14 Manholes and Inspection Chambers

The maximum distance between manholes shall be 30 meter unless specifically permitted otherwise. In addition at every change of alignment, gradient or diameter there shall be a manhole or inspection chamber. The distance between manhole or inspection chamber and gully chamber shall not exceed 6 meters unless permitted otherwise. Manhole shall be constructed so as to be water-tight under test. The channel or drain at the bottom of chamber shall be plastered with 1:2 cement sand mortar and finished smooth to the grade. The channels and drains shall be shaped and

laid to provide smooth flow.

Connection to existing pipelines shall be through a manhole Manholes shall be provided with standard covers, usually C.I. or as directed by the Engineer. The covers shall be close fitting so as to prevent gases from coming out.

3.15 MASONRY

3.15.1 Brick Masonry

All bricks shall be of first class (Class A) quality, well burnt, of uniform size, shape and colour free from cracks, flaws or nodules of free lime. Bricks shall be soaked in water for at least two hours prior to use and shall be laid truly horizontal and vertical in headers and stretchers with cement mortar consisting of one part of cement and four parts of sand, unless otherwise mentioned in the schedule of Items or directed by the Engineer, in layers not exceeding 1.5 M in height. Each layer shall be allowed at least 24 hours to settle itself before another layer is placed on it and every layer cured with water until the starting of next layer above it.

Materials for mortar such as sand and cement shall be of approved quality. Mortar shall be well mixed, first dry mixed and then by adding water slowly to have a thick workable consistency. Mortar shall be mixed in small batches consistent with the rate of consumption so that no mortar is used after one hour of mixing.

Mortar joints shall be kept uniformly 10 mm thick and all joints should be full of mortar. Brickwork shall be carried up regularly in plumb every course being horizontal. No vertical joints shall come directly over one another.

Joints of the brickwork shall be raked minimum 10 mm deep using raking tool while mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. The brickwork shall be kept moist for 14 days.

All bricks which absorb water more than 20% of their own dry weight after being immersed in water for 24 hours shall be rejected. Brick should be as per IS: 1077. Bricks shall have minimum crushing strength of 50 kg/Sq.cm

3.15.2 Stone Masonry

All stones shall be from approved quarries, hard, tough, durable, compact grained, uniform in texture and colour and free from decay, flaws, veins, cracks and sand holes. A stone shall not absorb more than 5 percent of its weight of water after 24 hours immersion. Samples shall be submitted by the Contractor and approved samples shall be retained by the Engineer for comparison of bulk supply.

Stone shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall not be less than 8 mm and not greater than 25 mm. At least two stones shall run the full width of the wall for every square meter of surface area.

3.15.3 Pointing to Masonry

After raking out of the joints, the brickwork shall be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water, mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitable tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean. The pointed surface shall be kept wet for at least three days for curing.

3.16 <u>PLASTER TO MASONRY AND CONCRETE</u>

Before application of plaster the surface shall be cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess water shall be mopped up.

Unless otherwise mentioned in the schedule of items plastering shall be done with cement sand mortar - 1 part by volume of cement to 4

parts by volume of clean, sharp, well graded sand. For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency. For lime gauge plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall than be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No mortar which has stood for more than half an hour shall be used. Plaster, when more than 12 mm thick, shall be applied in two coats. All plaster work shall correspond to IS: 1661- latest edition.

3.16.1 Finish

Generally, all plastered surfaces shall have a standard finish unless otherwise shown on the drawing or directed by the Engineer. The interior plaster shall be finished to a smooth surface by steel trowelling. The exterior surfaces shall be finished with a wooden float.

However, if shown on the drawing or directed by the Engineer the plastered surface shall have a neat cement finish. Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg per Sq.M. and rubbed smooth with a trowel

3.17 CEMENT CONCRETE (PLAIN AND REINFORCED)

Shall be as laid down in "Technical Specification for Cement Concrete (Plain and Reinforced)" Section - III.

4.0 TESTING AND ACCEPTANCE CRITERIA

4.1 ROADS

All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per direction of the

Engineer. No extra payment shall be made for such tests.

4.2 MASONRY AND PLASTERING

Masonry and finish to masonry and concrete shall fully comply with the drawings, approved samples and instructions of the Engineer with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

4.3 CEMENT CONCRETE

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS:456.

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SECTION – 7/B

CONCRETE ROADS

[PART-B]

CONSULTANT : PROCON ENGINEERS

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4.0	TESTING AND ACCEPTANCE CRITERIA

1.0 SCOPE

This specification covers all work required for the construction of concrete road including box-cutting, edging, sub-base, sub grade, unreinforced / reinforced concrete pavement include all incidental items of work not shown or specified but reasonably implied or necessary for the completion of the work.

This specification also includes all work required for drainage including road side drain, R.C.C. culverts, pipe-culverts, drainage pipes, manholes etc. and all other incidental items.

2.0 GENERAL

2.1 WORK TO BE PROVIDED FOR BY THE CONTRACTOR

The work to be provided for by the Contractor, unless specified otherwise, shall include but not be limited to the following:

(a) Furnish all labour, supervision, services, materials, equipment, tools and plants, transportation etc. required for the work.

(b) Submit for approval detailed schemes of all operations required for executing the work e.g. material handling, placement, services, approaches etc.

(c) To carry out and submit to the Engineer results of tests whenever required by the Engineer to assess the quality of work.

2.2 WORK TO BE PROVIDED FOR BY OTHERS

No work under this specification will be provided for by any agency other than the Contractor unless specifically mentioned elsewhere in the Contract.

2.3 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.

(a) Specification for road and bridge works of Ministry of shipping & Transport (Roads wing) Published by the IRC.

(b) IRC: 58 Guidelines for the design of Rigid Pavements for highways

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

(d) IS:456 Indian Standard Code of Practice for Plain and Reinforced Concrete.

(e) IS: 2212 Code of Practice for Brickwork.

(f) IS: 783 Code of Practice for Lying of Concrete Pipes.

(g) IRC: 15 Standard Specifications and Code of Practice for Construction of Concrete Roads.

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

2.4 CONFORMITY WITH DESIGNS

The contractor shall carryout the work as per the drawings issued to him and/or contractor's drawings which are approved by the Engineer and/or the Engineer's instructions.

2.5 MATERIALS TO BE USED

2.5.1 General

All materials required for the work shall be of best commercial variety and as approved by the Engineer.

2.5.2 Quality Control

The Contractor shall establish and maintain quality control for the various aspects of the work, method, materials and equipment used.

All works performed shall conform to the lines, grades, and cross sections and dimensions shown on the drawings or as directed by the Engineer. Permitted tolerances for road works are described hereinafter.

(a) Horizontal Alignments

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

(b) Longitudinal Profile

The levels of the sub grade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer, beyond tolerances mentioned below :

Sub-grade ± 25 mm

Sub-base ± 20 mm

3.0 EXECUTION

3.1 SHOULDER CONSTRUCTION

3.1.1 Description

This work shall consist of constructing shoulders on either side of the pavement, accordance with the requirements of this specification

and in conformity with the lines, grades and cross- sections shown on the drawings or as directed by the Engineer.

3.1.2 Materials

Shoulder may be of selected earth or granular material conforming to the requirements of embankment construction or granular sub- base construction respectively.

Hard Shoulders shall be 80mm thick PCC interlocking blocks(grade M-35) over PCC M-7.5 with sand bedding on an under-bed of 150mm thick WBM on either side of the roads. Precast Kerb stone, for construction of shoulder, shall be of precast concrete blocks having a concrete grade of M-25. The blocks shall be 100 mm wide and of suitable length and depth

3.1.3 Construction Operations

Except in the case of bituminous constructions, shoulders shall be constructed in advance of the laying of pavement courses. The compacted thickness of each layer of shoulder shall correspond to the compacted layer of pavement course to be laid adjacent to it. After compaction, the inside edges of shoulders shall be trimmed vertical and included area cleaned of all spilled material before proceeding with the construction of the pavement layer.

Regardless of the method of lying, all shoulder construction material shall be placed directly on the shoulder. Any spilled material dragged on to the pavement surface shall be immediately removed, without damage to the pavement and the area so affected thoroughly cleaned.

During all stages of shoulder construction, the required cross fall shall be maintained to drain off surface water.

3.2 KERB

3.2.1 Material

Kerb, if required for construction of footpath, shall consist of precast concrete blocks with a concrete grade of M-15. The blocks shall be 100 mm

wide and of suitable length. The depth of blocks unless otherwise mentioned elsewhere, shall be 375 mm considering 225 mm height of footpath from the road level

3.2.2 Laying

The Kerb shall be laid by cutting trenches 150 mm deep. The width of the trench shall be minimum and just sufficient to insert the kerbs. The inside faces of the Kerbs shall be in plumb and the gap between the block shall not be more than 10 mm.

The kerbs shall be thoroughly packed with a mixture of stone chips (50%) and moorum (50%) at the outside face. The laying and packing shall be done in a proper workmanlike manner acceptable to the Engineer.

3.3 SUB-BASE (GRANULAR SUB-BASE)

3.3.1 Description

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.

3.3.2 Materials

The materials to be used for the work shall be natural sand, moorum, gravel, crushed stone, crushed slag, crushed concrete, brick metal, laterite, kanker etc. or combinations thereof depending upon the grading required. The mixed materials shall be free from organic or other deleterious constituents and conform to one of the three grading given in Table-I below

TABLE-I

GRADING FOR GRANULAR SUB-BASE MATERIALS

Sr. No.	Sieve designation	Percent by weight passing the sieve		
		Grading 1	**Grading 2**	**Grading 3**
1.0	80 mm	100	100	100
2.0	63 mm	90-100	90-100	90-100
3.0	4.75 mm	35-70	40-90	50-100
4.0	75 micron	0-20	0-25	0-30
5.0	CBR Value (Minimum) for fraction of material passing 20 mm sieve	30%	25%	20%

Note: The material passing 425 micron sieve for all the three grading when tested according to IS: 2720 (Part V) shall have liquid limit and plasticity index of not more than 25 percent and 6 percent respectively.

3.3.3 Physical Requirements

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

3.3.4 Spreading and Compacting

Immediately prior to the laying of sub-base, the sub grade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary, and rolled with one pass of 8-10 tonne smooth wheeled roller.

The sub-base material shall be spread on the sub grade with the help of a drag spreader, motor grader or other approved means. The thickness of loose layers shall be so regulated that the maximum thickness of the layer after consolidation does not exceed 150 mm.

Moisture content of the loose material shall be checked in accordance with IS: 2720 (Part II) and suitably adjusted by sprinkling additional water from a hose line, truck mounted water tank or other approved means so that at the time of compaction it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS: 2720 (Part VIII). While adding water due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means if so directed by the Engineer until the layer is uniformly wet.

Immediately thereafter, rolling shall be started with 8 to 10 tonne smooth wheeled rollers or other approved plant. Rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated portions it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling the grade and camber shall be checked and any high spots or depressions which become apparent corrected by removing or adding fresh material.

Rolling shall be continued till the density achieved is at least 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.

3.4 CEMENT CONCRETE (PLAIN AND REINFORCED)

3.4.1 General

All concrete work shall be according to ISI relevant Codes unless mentioned

otherwise herein and the ISI Codes particularly IS:226, IS:455, IS:385, IS:1786 & IS:456 latest editions shall form a part of the present specification.

3.4.2 Materials

(a) Cement :

The cement used shall be ordinary Portland cement/ Blast Furnace slag cement/ Portland Pozzolana cement, sulphate resistant cement of approved manufacture and shall be fresh when delivered. Consignments shall be used in the order of delivery. Damaged or partly set cement shall not be permitted to be used and shall be removed from site at once.

Admixture shall be used only if approved by the Engineer. The Contractor shall furnish to the Engineer, the manufacturer's certificate for cement for each consignment, procured by the Contractor direct. If at any time, the Engineer feels that the quality of cement is not upto the specification, he can stop the work and send samples of cement for testing to an approved laboratory. The Contractor shall have no claim for any loss arising out of such suspension of work.

If the cement is procured by the Owner and issued to the Contractor, the Contractor shall satisfy himself at the time of taking delivery that quality and freshness of cement are upto the specified standard.

No complaint will be entertained later on from the Contractor for poor concrete work due to the poor quality of cement supplied by the Owner. All rectification work on this account shall be done entirely by the Contractor at his own expenses

(b) Aggregate :

(i) General

Aggregate shall consist of natural sand, crushed stone procured from a source known to produce satisfactory aggregate for concrete and shall be chemically inert strong,

hard, durable against weathering, of limited porosity and free from adhering coatings, clay lumps, coal and coal residues, clinkers, slag, organic and other impurities that may cause corrosion of the reinforcements or may impair the strength and/or durability of the concrete. They shall conform to IS: 383 - latest edition.

(ii) Sand and Fine Aggregate :

It shall be clean, sharp and coarse and free from all impurities and shall be washed and/or screened at the site if so demanded by the Engineer. Sand and fine aggregate shall correspond to IS: 383 - latest edition. The fine aggregate shall not contain more than 3 percent of clay or foreign matter. Fineness modulus of sand shall not be less than 2.5.

(iii) Coarse Aggregate:

This shall consist of broken trap, basalt or granite or some other suitable stone from a source to be approved by the Engineer and shall meet the requirements of IS: 383 - latest edition. The coarse aggregate shall be machine crushed, hard, strong, durable, free from clayey films or loamy admixtures, vegetable or organic matters and shall be washed with water and/or screened if so demanded by the Engineer. The aggregate shall be well graded. The pieces shall be angular in shape and shall have granular or crystalline surface. Friable, flaky and laminated pieces, mica and shell may be present only in such quantities that will not affect adversely the strength and/or durability of concrete and to the approval of the Engineer. The maximum size of coarse agrees gate shall be 38 mm for lean concrete and M10 Grade concrete and 20 mm for M15 Grade concrete.

Where permitted by the Engineer, the maximum size of the coarse aggregate may be large. All aggregate shall be uniformly graded. The amount of fine particles occurring in the Free State or as loose adherent shall not exceed 1% when determined by laboratory sedimentations tests. After 24 hours

immersion in water, a previously dried sample shall not have gained more than 10% of the weight.

(c) Water :

Water shall be clean, fresh and free from organic or deleterious matter in solution or in suspension in such amounts that may impair the strength or durability of the concrete. The Contractor shall, however, satisfy himself that the quality is upto the desired standard and shall also submit an analysis from an approved analyst if so desired by the Engineer, free of charge.

(d) Reinforcements :

The reinforcement shall be mild or to steel bars conforming to the latest edition of IS: 432 or IS: 1786.

All reinforcing bars must be completely free from grease, oil, dirt, scales, scrap able rust, bituminous material, paint, pitted surface and manufacturing defects.

(e) Tie bars.

Tie bars in longitudinal joints shall be deformed steel bars of strength 415 Mpa complying with IS: 1786 and in accordance with the requirements given below. The bars shall be free from oil, dirt, loose rust and scale. Design of tie bar shall be as per IRC: 58.

(i) Tie bars projecting across the longitudinal joint shall be projected from corrosion for 75mm on each side of the joints by a proactive coating of bituminous paint with the approval of the Engineer. The coating shall be dry when the tie bars are used.

(ii) Tie bars in longitudinal joints shall be made up into rigid assemblies with adequate supports and fixings to remain firmly in position during the construction of slab. Alternatively, tie barsat longitudinal joints may be mechanically or manually inserted into the plastic concrete

from the above by vibration using a method which ensure correct placement of bars and reoccupation of the concrete around the tie bars.

(iii) Tie bars shall be positioned to remain within the middle third of the slab depth as indicated in the drawing and approximately parallel to the surface and approximately perpendicular to the line of joints, with the centre of each bars on the intended line of the joints within a tolerance of ± 50 mm, and with a minimum cover of 30mm below the joint groove.

(f) Separation Membrane.

Separation membrane shall be used between the concrete slab and the sub base. Separation membrane shall be impermeable plastic sheeting 125 micron thick laid flat without creases. Before placing the separation membrane, the sub base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300mm and any damaged sheeting shall be replaced at the Contractors expense. The separation membrane may be nailed to the lower layer with concrete nail.

(g) Joints

The location and type of joints shall be shown in the drawing. The location of the joints should be transferred accurately at the site and mechanical saw cutting of joints done as per stipulated dimensions. It should be ensured that the full required depth of cut is made from edge to edge of the pavement. Transverse and Longitudinal joints in the pavement and sub base shall be staggered so that they are not coincident vertically and are at least 1m and 0.3m apart respectively. Sawing of joints shall be carried out with diamond studded blades soon after the concrete has hardened to take the load of the sawing machine and personal without damaging the texture of the pavement. Sawing operation could start as early as 6-8 hours depending upon the season. All joints shall be designed as per IRC: 58.

(h) Transverse joints.

Location of construction joints/ expansion joints shall be as per drawing. Transverse joints shall be straight within the following tolerance along the intended line of joints which is the straight line transverse to the longitudinal axis of the carriageway at the position proposed by the Contractor and agreed to by the Engineer, except at the junction or roundabouts where the position shall be as described in the drawing.

(i) Deviations of the filler board in the case of expansion joints from the intended line of the joint shall not greater than ± 10mm.

(ii) The best fit straight line through the joints grooves as constructed shall not more than 25mm from the intended line of the joint.

(iii) Deviations of the joint groove from the best fit straight line of the joint shall not be greater than 10mm.

(iv) Transverse joints on each side of the longitudinal joint shall be in line with each other and of the same type and width.

(i) Longitudinal joints.

The longitudinal joints shall be saw cut as per details of the joints shown in the drawing. The groove may be cut after the final set of the concrete. Joints should be sawn to at least 1/3 the depth of the ± 5mm as indicated in the drawing.

(i) Dowel bars

Dowel bars shall be mild steel rounds in accordance with details/ dimensions as indicated in the drawing and free from oil, dirt, loose rust or scale. They shall be straight free of irregularities and burring restricting slippage in concrete. The sliding ends shall be sawn or cropped clearly with no protrusions outside the normal diameter of the bar. The dowel

bar shall be supported on cradles/dowels chairs in pre-fabricated joint assemblies positioned prior to the construction of the slabs or mechanically inserted with vibration into the plastic concrete by a method which ensures correct placement of the bars besides full reoccupation of the concrete around the dowel bars.

Unless shown otherwise on the drawings, dowels bars shall be positioned at mid depth of the slab within a tolerance of ± 20mm, and cantered equally about intended lines of the joint within a tolerance of ± 25mm.

Dowel bars shall be covered by a thin plastic sheath for at least two thirds of the length from one end for dowels bars in contraction joints or half the length plus 50mm for expansion joints. The sheath shall be tough, durable and of an average thickness not greater than 1.25mm.

For expansion joints, a closely fitting cap 100mm long consisting of waterproofed cardboard or an approved synthetic material like PVC or GI pipes shall be placed over the sheathed end of each dowel bar. An expansion space at least equal in length to the thickness of the joint filler board shall be formed between the end of the cap and the end of the dowel bar by using compressible sponge. To block the entry of the cement slurry between dowels and cap it may be taped. Design of dowel bars shall be as per IRC: 58.

(j) Joint sealing compound.

The joint sealing compound shall be hot poured, electrometric type or cold polysulphide type having flexibility, resistance to age hardening and durability. If the sealant is of hot poured type it shall confirm to AASHTO M282 and cold applied sealant shall be in accordance with BS5212 (PART 2).

3.4.3 Storage of Materials

(a) Cement :

Cement shall be stored at the works in such a manner as to prevent deterioration either through moisture or intrusion of foreign matter. Sufficient storage shall be arranged by the Contractor to ensure continuity of consumption. Cement shall be stored in easily countable stacks of minm. Cap. 2000 M.T

(b) Aggregates :

Aggregates shall be stored on planking, steel plates or concrete. Different sizes shall be separated with wooden, steel, or concrete bulkheads. Care shall be taken to prevent any segregation of various sizes of particles. The aggregates must not be allowed to come in contact with dirt, clay and other injurious substances at any stage. The aggregate shall be stored in easily measurable stacks. Procurement must be at least two months in advance of consumption in dry season and four months in advance in rainy season.

(c) Reinforcement :

Reinforcing steel shall be stored as far as possible under cover. It shall be protected from oil, grease, dirt, etc. The stacks shall be easily measurable.

3.4.4 Workmanship

(a) Reinforcement

(i) Bending :

Reinforcement bars shall be bent by machine or other approved means producing a gradual and even motion. All the bars shall be cold bent unless otherwise approved. Bars correctly bent only will be used. Bends and shapes shall comply strictly with the dimensions in the approved bar bending schedule. Bending schedule shall be prepared by the Contractor and got

approved by the Engineer before bending and he shall be entirely responsible for its correctness. No reinforcement shall be bent when in position in the work without approval of the Engineer, whether or not it is partially embedded in concrete. Unless described otherwise, lapping dimensions shall conform to IS:456 - latest edition and all bending shall correspond to IS:2502 - latest edition.

(ii) Placing in Position :

Fixing of reinforcement shall correspond to IS: 2502 - latest edition. Reinforcements shall be accurately fixed and maintained in position by such means as mild steel chairs and concrete spacer pieces, Bars intended to be in contact at passing points shall be securely bound together at all such points by No. 20G annealed soft iron wire conforming to IS:280 - latest edition. Binders and the like shall tightly embrace the bars with which they are intended to be in contact and shall be securely bound. The vertical distances between successive layers of bars shall be maintained by provision of mild steel spacer bars at such intervals that the main bars do not sag perceptibly between adjacent spacer bars.

The placing of reinforcement shall be completed well in advance of concreting immediately before concreting; the reinforcement shall be examined for accuracy of placing and cleanliness by the Engineer and corrected if it is so desired by him. The cover for concrete over the reinforcements shall be as shown or as specified on the approved drawings. Unless otherwise directed, all laps shall be minimum 52 times the diameter of the bar in case of H.T. deformed bar and 40 times diameter of the bar in case of mild steel. If the bars in a lap are not of same diameter, the smaller will guide the lap length. The Where concrete blocks are used for ensuring the cover and position, they shall be made of mortar not leaner than one (1) part cement to two (2) parts sand and cured for at least seven days.

(b) Formwork :

The formwork shall conform to the shape, line and dimensions as shown on the plans and shall be made of timber close and tight to prevent leakage of mortar with necessary props, bracings and wedges sufficiently strong and stable so that it should not yield on laying of concrete. Formwork shall conform to IS: 456 - latest edition - in respect of above and stripping time, cleaning and oiling, etc.

(c) Concrete :

Mix: The following concrete mixes shall be used for concrete roads.

Grade M15 with minimum cement content of 325 kg/cum shall be used for DLC layer below PQC and minimum grade of M35 with minimum cement content of 360 kg/cum shall be used for PQC.

(i) Water cement ratio and slump shall be determined to suit strength requirements of the concrete mix.

(ii) Mixing :

The aggregate and sand shall be washed free from all dust and earthy matter if required by the Engineer. The above materials will then be accurately measured in boxes. The quantity of cement shall be determined by weight. The quantity of water shall be predetermined after allowing for moisture content in the aggregate. All the ingredients as proportioned shall then be mixed in a mechanical mixer till the mass is uniform in texture and consistency, but in no case the mixing time shall be less than two minutes. Hand mixing if permitted by the Engineer as a special case shall be carried out on a water tight platform using 10% extra cement at Contractor's cost and care shall be taken to ensure that the mixing is continued till the mass is uniform in colour and consistency.

(iii) Placing and Compacting :

Concrete shall be transported from the place of mixture to the place of final deposit within 45 minutes after water has been added and shall be compacted before initial setting commence and should not be subsequently disturbed. Method of transporting and placing shall be such as to preclude segregation. Concrete shall be thoroughly worked around the reinforcements, etc. and into all corners of formwork. For compaction of concrete, mechanical vibrators shall be used. Concrete shall not be placed in water. Mixing, transporting, placing and compacting of concrete shall conform to IS:456 - latest edition.

(iv) Curing :

Concrete shall be cured for at least 28 days from the date of placing of concrete.

(v) Testing of Concrete :

Concrete shall be tested in accordance with IS:516 - latest edition and accepted in accordance with IS:456 - latest edition.

4.0 TESTING AND ACCEPTANCE CRITERIA

4.1 ROADS

All testing, as mentioned in the body of the specification and as mentioned in Clause No. 900 of Specification for Roads and Bridge Works, 1983 published by IRC on behalf of Ministry of Shipping and Transport (Roads Wing) shall be carried out by the Contractor as per direction of the Engineer. No extra payment shall be made for such tests.

4.2 MASONRY AND PLASTERING

Masonry and finish to masonry and concrete shall fully comply with the drawings, specifications, approved samples and instructions of the Engineer with respect to lines, levels, thickness and any other special criteria as mentioned in the body of the specification or as shown on drawing.

4.3 CEMENT CONCRETE

The strength requirements and acceptance criteria shall conform to the relevant clauses of IS: 456.

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SECTION – 8

MASONRY & ALLIED WORKS

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	I. S. CODE

1.0 SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, protection, maintenance and handing over of masonry and allied works for use in structures and locations covered under the scope of the Contract.

2.0 INSTALLATION

2.1 SOLING

2.1.1 Brick Soling

The ground shall be dressed, consolidated by ramming or by light rolling and a 12 mm thick cushion of sand laid. On the sand cushion the bricks shall be laid with fine joints and placed firmly in position by hammering with wooden mallet. The surface shall be free from undulations. The 'frog' side shall be on the underside. The joints shall be broken the in all direction and bricks cut as required. Orientation shall be as desired by the Engineer. After laying of each layer of bricks sand shall be spread over and worked into the joints to pack the bricks tight.

2.1.2 Stone Soling

The stones for soling shall be selected on the basis of thickness of soling as shown as the drawings. The larger stones shall be laid and the gaps filled by smaller stones. The interstices shall then be firmly packed with sand by flooding with water.

2.2 BRICK EDGING

Excavation shall be done close to the brick dimensions and in perfect alignment. Bricks shall be firmly placed by hammering with wooden mallets and sides and joints packed firmly with earth so that the edging is not disturbed easily. Alignment and level shall be acceptable to the Engineer.

2.3 MASONRY

2.3.1 All masonry work shall be true to lines and levels as shown on drawings. All masonry shall be tightly built against structural members and bonded with dowels, inserts etc. as shown on drawings.

2.3.2 Mortar

Mix for mortar shall be specified in the Schedule of Items.

When lime is used hydrated lime shall be mixed with water to form putty and stored with care to prevent evaporation for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream, passed through a No. 10 sieve and stored avoiding evaporation for seven days before use.

Lime putty and sand in proper proportion shall be mixed on a water-tight platform with necessary addition of water and thoroughly ground in a mortar mill. This mix shall be transferred to a mechanical mix, required quantity of cement added and the content mixed for at least 3 minutes. Mixtures of lime putty and sand may be stored avoiding drying out. For cement sand mortar cement and sand in requisite proportions shall be mixed dry in a mechanical mixer and then water added and mixed further. Minimum quantity of water shall be added to achieve working consistency.

Surplus mortar droppings from masonry, if received on surface free from dirt may be mixed with fresh mortar if permitted by the Engineer who may direct addition of additional cement. No mortar which has stood for more than half an hour shall be used.

2.3.3 Brick Masonry

Bricks shall be soaked by submergence in clean water for at least two hours in approved vats before use. Bricks shall be laid in English bond unless specified otherwise. Broken bricks shall not be used. Cut bricks shall be used if necessary to complete bond or as closers. Bricks shall be laid with frogs upwards over full mortar beds. Bricks shall be pressed into mortar and tapped into final position so as to embed fully in mortar. Inside faces shall

be buttered with mortar before the next bricks is placed and pressed against it. Thus all joints between bricks shall be fully filled with mortar.

Mortar joints shall be kept uniformly 10 mm thick. All joints on face shall be raked to minimum 10 mm depth using raking tool while the mortar is still green to provide bond for plaster or pointing. Where plaster or pointing is not provided, the joints shall be struck flush and finished immediately. Brickworks two bricks thick or more shall have both faces in true plane. Brickwork of lesser thickness shall have one selected face in true plane.

2.3.4 Exposed Brickwork

Brickwork in superstructures which is not covered by plaster shall be as shown on drawing and executed by specially skilled mason. Courses shall be truly horizontal and vertical joints truly vertical. Wooden straight edges with brick course graduations and position of window sills and lintels shall be used to control uniformity of brick courses. Masons must check workmanship frequently with plumb, spirit level, rule and string. All brick-work shall be cleaned at the end of days work. If face bricks are specified in the drawings, the brickwork shall be in composite bricks, with face bricks on the exposed face and balance in routine bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from routine bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified. Where face bricks are used carborandum stone shall be used for rubbing down.

2.3.5 Reinforced Brickworks

Reinforcements shall be as specified in the drawings. All reinforcements shall be thoroughly cleaned and fully embedded in mortar. Where M.S. bars are used as reinforcement, these shall be lapped with dowels if left in R.C. columns or welded to steel stanchions.

2.3.6 Stone Masonry

Stones shall be thoroughly soaked before laying. Stones shall be laid on their natural quarry beds. Individual stones shall be fitted with mallet and properly wedged to reduce thickness of mortar joints. Thickness of joint shall be not less than 8 mm and not greater than 25 mm. Al least two stones shall run the full width of the wall for every square meter of surface area.

2.3.7 Exposed Stonework

Stonework which is to be kept exposed shall be as shown on drawing or described in the Schedule of Items. It shall be executed by specially skilled mason. Stones used for exposed face shall be specially selected. All exposed stone faces shall be kept clean and free from mortar and pointed up neatly as the work proceeds in a manner called for in the drawings or instructions. A sample wall, 10 sq.m. in area shall be built and approved by the Engineer and all works shall match with this sample.

2.3.8 Composite Masonry

Where stonework facing with brick masonry backing is specified the bond between them shall be achieved by bond stones of dimensions and frequency as desired by the Engineer.

2.3.9 Expansion & Separation Joints

Location of joints shall strictly be as shown on drawings or as instructed by the Engineer. Expansion joints shall be as shown on drawings. Expansion joint filler boards and sealing strips shall have minimum transverse joints. Transverse joints shall meet the approval of the Engineer.

Separation joints shall be with standard water proof paper or with alkathene sheets about 1 mm in thickness. Length and sealing of laps shall be to the satisfaction of the Engineer

2.3.10 Mouldings, Cornices, Drip Course

These shall be made as shown in drawings. Bricks or stone shall be cut and dressed as required. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborandum stone.

2.3.11 Curing

Masonry shall be cured by keeping it wet for seven days from the date of laying. In dry weather at the end of days work top surface of masonry shall be kept wet by ponding.

2.3.12 Embedding of fixtures

All fixtures shall generally be embedded in mortar and masonry units shall be cut as required.

2.3.13 Encasing of Structural Steel

This shall be done by building masonry work round flanges, webs etc. and filling the gap between steel and masonry by minimum 12 mm thick mortar. Encased members shall be wrapped with chicken wire mesh when shown on drawings or instructed by the Engineer. The minimum lap in chicken wire mesh shall be 50 mm.

2.4 DAMP PROOF COURSE

Unless otherwise specified Damp-proof course shall be 40 mm or as per schedule thick 'artificial stone' in proportion 1:1-1/2:3 cement sand stone- chips (10 mm down) with admixture of a waterproofing compound as approved by the Engineer. The percentage of admixture shall be as per manufacturer's specifications but not less than 2% by weight of cement. The top surface shall be double chequered and cured by pond for seven days.

2.5 DAMP PROOF MEMBRANE

Damp proof treatment using fibre or hessian base bitumen felt shall be 6, 8 or 10 course treatment as specified in IS: 1609. The number of courses shall be as mentioned. Sequence or work shall be as directed by the Engineer. Extreme care shall be taken to prevent damage to felt during and after laying. The Contractor shall be obliged to rectify any leakage appearing within 5 years of installation by removing and renewing the coats at the point of leakage.

Where shown on drawing, damp proof membrane with one layer bitumen paper or one layer alkathene sheet shall be laid with minimum 150 mm lap under slabs on grade.

3.0 I.S. CODES

Some of the important relevant codes for this section are:

(a)	IS:1127	:	Recommendations for dimensions and workmanship of natural building stones for masonry work.
(b)	IS:1597	:	Code of Practice for Construction of stone Masonry.
(c)	IS:1609	:	Code of Practice for laying Damp-proof treatment using bitumen felts.
(d)	IS:2212	:	Code of Practice for Brickwork.
(e)	IS:2250	:	Code of Practice for preparation and use of Masonry Mortar.
(f)	IS:5134	:	Bitumen Impregnated Paper & Board.

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SECTION – 9

FINISH TO MASONRY & CONCRETE

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	ACCEPTANCE CRITERIA
4.0	I. S. CODES

1.0 SCOPE

This Specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of finishing items for masonry and concrete. This shall also include the work to be done to make the surface suitable for receiving the finishing treatment. Before commencing finishing items the Contractor shall obtain the approval of the Engineer regarding the scheduling of work to minimise damage by other trades. He shall also undertake normal precaution to prevent damage or disfiguration to work of other trades or other installation.

2.0 INSTALLATION

2.1 PREPARATION OF SURFACE

All joints in masonry walls shall be raked out to a depth of at least 10 mm with a hooked tool made for the purpose while the mortar is still green. Walls shall be brushed down with stiff wire brush to remove all loose dust from joints and thoroughly washed with water. All laitance shall be removed from concrete to be plastered.

For all types of flooring, skirting and dado work, the base cement concrete slab or masonry surface shall be roughened by chipping and cleaned of all dirt, grease or loose particles by hard brush and water. The surface shall be thoroughly moist to prevent absorption of water from the base course. Any excess of water shall be mopped up.

At any point, the level of base shall be lower than the theoretical finished floor level by the thickness of floor finish. Any chipping or filling to be done to bring the base in the required level shall be brought to the notice of the Engineer and his approval shall be taken regarding the method and extent of rectification work required.

Prior to commencement of actual finishing work, the approval or the Engineer shall be taken as to the acceptability of the base.

2.2 PLASTERING

2.2.1 Mortar

Mortar for plastering shall be as specified in the drawings.

For sand cement plaster, sand and cement in the specified proportion shall be mixed dry on a watertight platform and minimum water added to achieve working consistency.

For lime gauged plaster, lime putty or hydrated lime and sand in the required proportion shall be mixed on a watertight platform with necessary addition of water and thoroughly ground in mortar mill. This mix shall then be transferred to a mechanical mixer to which the required quantity of cement is added and mixed for at least 3 minutes.

No plaster which has stood for more than half an hour shall be used; plaster that shows tendency to become dry before this time, shall have water added to it

2.2.2 Application of Plaster

Plaster, when more than 12 mm thick, shall be applied in two coats - a base coat followed by the finishing coat. Thickness of the base coat shall be sufficient to fill up all unevenness in the surface; no single coat, however, shall exceed 12 mm in thickness. The lower coat shall be thicker than the upper coat, the overall thickness of the coats shall not be less than the minimum thick-ness shown on the drawings. The undercoat shall be allowed to dry and shrink before applying the second coat of plaster. The under- coat shall be scratched or roughened before it is fully hardened to form a mechanical key. The method of application shall be 'thrown on' rather than 'applied by trowel'.

To ensure even thickness and true surface, patches of plaster about 100 mm to 150 mm square or wooden screed 75 mm wide and of the thickness of the plaster, shall be fixed vertically about 2000 mm to 3000 mm apart, to act as gauges. The finished wall surface shall be true to plumb, and the Contractor shall make up any irregularity in the brickwork with

plaster.

All vertical edges of brick pillars, doorjambs etc. shall be chamfered or rounded off as directed by the Engineer. All drips, grooves, mouldings and cornices as shown on drawing or instructed by the Engineer shall be done with special care to maintain true lines, levels and profiles. After the plastering work is completed, all debris shall be removed and the area left clean. Any plastering that is damaged shall be repaired and left in good condition at the completion of the job.

2.2.3 Finish

Generally, the standard finish shall be used unless otherwise shown on drawing or directed by the Engineer. Wherever any special treatment to the plastered surface is indicated, the work shall be done exactly as shown on the drawings, to the entire satisfaction of the Engineer regarding the texture, colour and finish.

(a) Standard Finish

Wherever punning is indicated, the interior plaster shall be finished rough. Otherwise the interior plaster shall generally be finished to a smooth surface. The exterior surface shall generally be finished with a wooden float.

(b) Neat Cement Finish

Immediately after achieving a true plastered surface with the help of a wooden straight edge, the entire area shall be uniformly treated with a paste of neat cement at the rate of one (1) kg. Per Sq.M. and rubbed smooth with a trowel.

(c) Coloured Plaster Finish

This shall be done in the same way as specified in Clause 2.2.2 of this specification but using coloured cement in place of ordinary cement. When coloured plastering is specified in more than one coat, the top coat only shall be made with coloured cement.

Coloured cement shall be either ready mixed material or may be obtained by mixing pigments and cement at site, as approved by the Engineer. The pigments to be mixed with cement shall conform to Appendix-A of IS: 2114 latest edition. Samples of colouring material shall be submitted to the Engineer for approval and material procured, shall conform in all respects to the approved samples, which shall remain with the Engineer. All coloured cement and/or pigments shall be stored in an approved manner in order to prevent deteriorations.

(d) Pebble-dash Finish

Mortar of required thickness consisting of 1 part cement and 4 parts sand by volume shall be applied in the usual manner as described under plastering Clause 2.2.2.of this specification While the mortar is still plastic small pebbles or crushed stone of size generally from 10 mm to 20 mm as approved by the Engineer shall be thrown on the plastered surface. The aggregate shall be lightly tapped into the mortar with a wood float or the flat end of a trowel, in order to ensure satisfactory bond between the dashing and the mortar.

(e) Rough-Cast Finish

A wet plastic mix of 3 parts coloured cement 6 parts sand and 4 parts aggregate by volume (gravel or crushed stone of size from 6 mm to 12 mm as approved by the Engineer) shall be thrown on to the wall by means of a plaster's trowel and left in the rough condition.

(f) Scraped Finish

Ordinary plaster as described under Clause 2.2.2 of this specification after being levelled and allowed to stiffen for a few hours, shall be scraped with a steel straight edge to remove the surface skin. The pattern shall be as approved by the Engineer.

(g) Textured Finish

Mortar consisting of 1 part cement and 3 parts sand by volume shall be applied in a manner as specified under "Plastering" Clause

2.2.2. of this specification Ornamental treatments in the form of horizontal or vertical rib texture fan texture etc. shall be applied by means of suitable tools to the freshly applied plastered surface, as approved by the Engineer

2.2.4 Curing

All plastered surfaces after laying, shall be watered, for a minimum period of seven days, by an approved method, and shall be protected from excessive heat and sunlight by suitable approved means. Moistening shall commence, as soon as the plaster has hardened sufficiently and not susceptible to damage. Each individual coat of plaster shall be kept damp continuously, for at least two days, and then dried thoroughly, before applying the next coat.

2.3 POINTING TO MASONRY

All joints of brickwork shall be raked out to a depth of 10 mm with a hooked tool made for the purpose while the mortar is still green. The brickwork shall then be brushed down with a stiff wire brush, so as to remove all loose dust from the joints and thoroughly washed with water. Mortar consisting of 1 part cement and 3 parts clean, sharp, well graded sand by volume shall be pressed carefully into the joints and finished with suitably tools to shape as shown on the drawings. Any surplus mortar shall be scraped off the wall face leaving the surface clean.

The pointed surface shall be kept wet for at least three days for curing.

2.4 PLASTER WITH METAL LATH

The supports, hangers, brackets, cleats etc. shall be as shown on drawings and/or as approved by the Engineer. These shall have a coat of prime paint before and another coat of approved paint after erection.

The metal lath shall be expanded metal, with 12 mm x 38 mm mesh, 16 BG thick and 3 mm wide strands. Side laps shall be minimum 12 mm and end laps 25 mm minimum. The plastering shall be minimum 20 mm thick measured from the back of lath and applied in two layers.

The mortar for plastering shall consist of 1 part cement, 1/2 part lime and 4 parts sand by volume, or 1 part cement and 4 parts sand by volume mixed as specified in plastering, Clause 2.2.1. of this specification. The application, finish etc. shall be as specified under relevant clause above. A 2 mm Plaster of Paris punning shall be applied over plaster as a finishing coat to give perfectly smooth and even finish.

2.5 LIME PUNNING

For plastered surfaces, where an even smooth surface is specified, lime punning with 5 parts of shell lime properly slaked, strained and aged, mixed with 1 part clean, washed, sieved, fine sand by volume shall be done. The thickness of lime punning shall be not less than 2 mm and more than 3 mm. The plastered surface shall be saturated with water before application of the lime punning. The punning shall be applied by skilled workman and given a smooth and even finish free from undulations, cracks etc. and to the satisfaction of the Engineer.

2.6 PLASTER OF PARIS PUNNING

Plastered surfaces, where specified shall be finished with Plaster-of-Paris punning. The material shall be from approved manufacturers and approved by the Engineer. The thickness of the punning shall be 2 mm and shall be applied by skilled workmen. The finish shall be smooth, even and free from undulation, cracks etc.

Before bulk work is taken in hand, a sample of punning shall be done on roughly 10 Sq. M. area and approval of the Engineer taken. The work shall then be taken in hand as per approved sample.

2.7 STONE FACING

Stone facing where specified shall be done as shown on design drawings and approved shop drawings. The stone shall be as specified on drawings. Samples of stone shall be submitted to the Engineer for approval and then bulk purchase made. The Contractor shall submit three copies of shop drawing for the Engineer's approval before commencing the work.

The thickness of facing stone shall be not less than 25 mm unless otherwise specified on drawings.

The stone slabs shall be cut and finished to sizes as per pattern shown on drawings.

They shall be fastened to wall with suitable non-corrodable anchorage as approved by the Engineer. Where mild steel clamps, stays etc. are used for anchorage, they shall be galvanised (weight of zinc coating shall not be less than 700 gms per square meter of surface) to prevent rust stains developing on the finished surface. There shall be at least 12 mm gap between the stone and masonry, which shall be filled up and packed by a mortar of 1 part cement and parts of sand by volume. After the mortar is set and cured for at least four days, the exposed surface shall be rubbed and polished as approved by the Engineer. The completed surface shall be neat, or uniform texture and acceptable to the Engineer.

Where pointing is specified on drawings it shall be done by mortar as specified on drawings.

3.0 ACCEPTANCE CRITERIA

Finish to masonry and concrete shall fully comply instructions of the Engineer with respect to lines, levels, thickness, colour, texture, pattern and any other special criteria as shown on drawings.

4.0 I.S. CODES

Important relevant code for this Section:

(a) IS 1661 : Code of practice for cement and cement-lime plaster finish on walls & ceilings

(b) IS4101 : Code of practice for external facings and veneers

VOLUME VI-B

SECTION – 10

FLOOR FINISHES AND ALLIED WORKS

CONSULTANT : PROCON ENGINEERS

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1.0 SCOPE

This specification covers furnishing, installation, finishing, curing, testing, protection, maintenance till handing over various types of floor finishes and allied items of work as listed below:

(a) In Situ Finishes

(i) Integral finish to concrete base

(ii) Red Oxide of Iron finish

(iii) Terrazzo finish

(iv) Granolithic finish

(v) Patent Stone

(vi) Metallic Hardener like "Ironite" finish

(vii) Mastic Asphalt finish

(viii) Chemical Resistant finish

(b) Tiled Finishes

(i) Terrazzo tile

(ii) Chequered tile

(iii) Glazed tile

(iv) Tesserae (Mosaic etc.)

(v) Chemical Resistant

(vi) Rubber, Vinyl etc.

(vii) Stone Slab

1.1 BASE

The base to receive the finish is covered under other relevant specifications.

1.2 SEQUENCE

Commencement, scheduling and sequence of the finishing works shall be planned in detail and must be specifically approved by the Engineer in view the activities of other agencies working in that area. However, the Contractor for the finishing items shall remain fully responsible for all normal precautions and vigilance to prevent any damage whatsoever till handing over.

2.0 INSTALLATION

2.1 SPECIAL MATERIALS

Basic materials are covered under Specification "Properties Storage and Handling of Common Building Materials". Special materials required for individual finishing items are specified under respective items. In general, all such materials shall be as per relevant I.S. Codes where available. In all cases these materials shall be of the best quality available indigenously, unless specified otherwise.

The materials for finishing items must be procured from well-reputed specialised manufacturers and on the basis of approval of samples by the Engineer. The materials shall be ordered, procured and stored well in advance to avoid compulsion to use substandard items to maintain in the construction schedule.

2.2 WORKMANSHIP

Only workers specially experienced in particular items of finishing work shall be engaged, where such workers are not readily available, with the Engineer's permission, experienced supervisor recommended by the manufacturer shall be engaged. In particular cases where the Engineer so desires the Contractor shall get the finishing items installed by the manufacturer.

2.3 PREPARATION OF THE BASE SURFACE

The surface to be treated shall be thoroughly examined by the Contractor. Any rectification necessary shall be brought to the notice of the Engineer and his approval shall be taken regarding method and extent of such rectification work.

For all types of flooring, skirting, dado and similar locations, the base to receive the finish shall be adequately roughened by chipping, raking out joints and cleaning thoroughly all dirts, grease etc. with water and hard brush and detergent if required, unless otherwise directed by the manufacturer of any special finishing materials or specifically indicated in this specification under individual item.

To prevent of water from the finishing treatment the base shall be thoroughly soaked with water and all excess water mopped up.

The surface shall be done dry where adhesives are used for fixing the finishes.

Prior to commencement of actual finishing work the approval of the Engineer shall be taken as per the acceptability of the surface.

2.4 IN SITU FINISHES

2.4.1 Integral Finish to Concrete Base

While the surface of the concrete laid as per specification for 'Cement Concrete' has been fully compacted and levelled but the concrete is still 'green' a thick slurry made with neat cement shall be applied evenly and worked in with iron floats. When the slurry starts to set it shall be pressed with iron floats to have a firm compact smooth surface without trowel mark or undulations.

This finish shall be as thin as possible by using 2.2 kg. of cement per Sq. M. of area.

The surface shall be kept in shade for 24 hours and then cured for at least 7 days continuously by flooding with water. The surface shall not be subjected

to any load or abrasion till 21 days after lying.

As desired by the Engineer the surface, while still 'green' shall be indented by pressing strings, the marking shall be of even depth, in straight lines and the panels shall be of uniform and symmetrical patterns.

2.4.2 Red Oxide of iron Finish

It shall consist of an underbed and a topping over already laid and matured concrete base.

(a) Thickness

Unless otherwise specified the total thickness of the finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall (not less than 10 mm) while the topping shall be of uniform thickness the underbid may vary in thickness to provide necessary slopes. The vertical surface shall project out 6 mm from the adjacent plaster or other finishes. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

(b) Mix

(i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 2 parts coarse sand and 4 parts 10 mm down graded stone chips by volume. For vertical and similar surfaces the mix shall consist of 1 part cement to 3 parts coarse sand by volume.

(ii) Topping

For the topping cement, screened through a fine mesh and red oxide of iron pigment powder similarly screened shall be dry mixed thoroughly in right proportions to produce the

desired colour when laid. The mix shall then be prepared with 1 part cement (mixed with pigment) and 3 parts coarse sand volume. The whole quantity required for each visible area shall be prepared in one batch to ensure uniform colour.

(c) Laying

The underbed shall be laid in panels of mixing area 5 Sq. M. each and no side shall be more than 2.5 along. For outdoor locations the maximum area shall be 2.0 Sq. M. The forms for the panels shall have perfectly aligned edges to the full depth of the total thickness of finish. If specified aluminium or glass dividing strips shall be used.

The panels shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid until the contraction of the latter has taken place. The underbed shall be laid, compacted, levelled and brought to proper grade with a screed or float. The topping shall be placed after about 24 hours while the underbed is still somewhat 'green' but firm enough to receive the topping. The surface of the underbed shall be roughened for better bonding. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water to achieve a compact dense mass fully bonded with the underbed. The topping shall then be levelled up by trowelling and finished smooth with a slurry made with already prepared cement and pigment mixture. About 2.0 Kg. of the mixture shall be consumed/per Sq.M. for horizontal surface, and 1.0 Kg. for vertical surface. The surface shall be cured for seven days by keeping it moist.

(d) Polishing

About 36 hours after laying when the surface has hardened sufficiently it shall be polished with polishing stone till a smooth shiny surface to the satisfaction of the Engineer, is achieved. The finish shall be washed and cleaned just before handing over.

2.4.3 Terrazo Finish : In Situ

It shall consist of an underbed and a topping laid over an already laid and matured concrete base.

(a) Thickness

Unless otherwise specified the total thickness of the finish shall be minimum 40 mm for horizontal and 25 mm for vertical surface of which the topping shall be not less than 10 mm. While the topping shall be of uniform thickness the underbed may very in thickness to provide necessary slopes. The vertical surface shall project cut 6 mm from the adjacent plaster or other finish. Necessary cutting into the surface receiving the finish shall be done to accommodate the specified thickness.

All junctions of vertical with horizontal shall be rounded neatly to uniform radius of 25 mm.

(b) Mix

(i) Underbed

The underbed for floors and similar horizontal surfaces shall consist of a mix of 1 part cement, 1.1/2 parts sand and 3 parts stone chips by volume. For vertical surfaces the mix shall consist of 1 part cement to 3 parts sand by volume. The sand shall be coarse. The stone chips shall be 10 mm down well graded. Only sufficient water to be added to give a workable consistency.

(ii) Topping

The mix for the topping shall be composed of cement, colour pigment, marble dust and marble chips. Proportions of the ingredients shall be such as to produce the terrazzo of colour texture and pattern approved by the Engineer. The cement shall be white or grey or a mixture of the two to which pigment shall be added to achieve the desired colour. To 3

parts of this mixture 1 part marble powder by volume shall be added and thoroughly mixed dry. To 1 part of this mix 1 to 1.1/2 parts of marble chips by volume shall be added and thoroughly mixed dry again.

The pigment must be stable and no fading. It must be very finely ground. The marble powder shall be from white marble and shall be finer than IS Sieve No. : 30. The size of marble chips may be between 1 mm to 20 mm.

Sufficient quantity to cover each visible area shall be prepared in one lot to ensure uniform colour. Water to make it just workable shall be added to a quantity that can be used up immediately before it starts to set.

(c) Laying

The underbed shall be laid in panels. The panels shall not be more than 5 sq.m in area of which no side shall be more than 2.5 M long. For exposed locations the maximum area of a panel shall be 2.0 Sq. M. The panel shall be laid in alternate bays or chequered board pattern. No panel shall be cast in contact with another already laid until the latter has contracted to the full extent.

Dividing strips made of aluminium or glass shall be used for forming the panels. The strips shall exactly match the total depth of underbed plus topping.

After lying, the underbed shall be levelled compacted and brought to proper grade with a screed or float.The topping shall be laid after about 24 hours while the underbed is still somewhat "green" but firm enough to receive the topping. Slurry of the mixture of cement and pigment already made shall be spread evenly and brushed in just before laying the topping. The topping shall be rolled for horizontal areas and thrown and pressed for vertical areas to extract all superfluous cement and water and to achieve a compact dense mass fully bonded with the underbed. The surface of the topping shall be trowelled over, pressed and brought to a smooth dense surface showing a minimum 75% area covered by marble chips in a even

pattern of distribution.

(d) Curing

The surface shall be left for curing for about 12 to 18 hours and then cured by allowing water to stand on the surface or by covering with wet sack for four days.

(e) Grinding and Polishing

When the surface has sufficiently hardened it shall be watered and ground evenly with rapid cutting coarse grade (no.60) grit blocks, till the marble chips are exposed and the surface is smooth. Then the surface shall be thoroughly washed and cleaned. A grout with already prepared mixture of cement and pigment shall be applied to fill up all pinholes. The surface shall be cured for 7 days by keeping it moist and then ground with fine grit blocks (no.: 120). It shall again be cleaned with water, the slurry applied again to fill up any pinholes that might have appeared and allowed to be cured again for 5 days. Finally, the surface is ground a third time with very fine grit blocks (no.: 320) to get smooth surface without any pinhole. The grinding shall be done by a suitable machine. Where grinding machine can not be used hand grin- ding may be allowed when the first rubbing shall be with carborundum stone of coarse grade (no.60), second rubbing with medium grade (no.: 80) and final rubbing and polishing with fine grade (no.: 120). The surface shall be cleaned with water, dried and covered with soil free, clean sawdust if directed by the Engineer. The final polishing shall be positioned till before handing over if desired by the Engineer. Just before handing over the surface shall be dusted with oxalic acid at the rate of 0.33 gm. per. Sq.M, water sprin- kled on to it and finished by buffing with felt or hessian bobs. The floor shall be cleaned with soft moist rag and dried. However, all excess wax polish to be wiped off and the surface to be left glossy but not slippery.

2.4.4 Granolithic Finish

Granolithic finish shall either be laid monolithically over base concrete or separately over hardened base concrete.

(a) Thickness

The finish shall be average 20 mm and minimum 12 mm thick, unless specified otherwise.

(b) Mix

The mix shall consist of 1 part cement: 1 part coarse sand: 2 parts coarse aggregate by volume.The coarse aggregate shall be very hard like granite and well graded between 6 mm and 12 mm. Minimum quantity of water to get workability shall be added.

(c) Laying of Monolithic Topping

The concrete base shall be laid as per specification "Cement Concrete" and levelled upto the required grade. The form shall remain sufficiently protruding to take the finish.

Within about 3 hours of laying the base while it is still fully "green" the topping shall be laid evenly to proper thickness and grade. If considered necessary the surface of the base shall roughened by wire brushing. Unless manual operation is permitted by the Engineer, mechanical vibrators of suitable design shall be used to press the topping firmly and work vigorously and quickly to secure full bond with concrete base.

The laitance brought to the surface during compression shall be removed carefully without disturbing the stone chips. The surface shall then the lightly trowelled to remove all marks. When sufficiently set, hand trowelling shall be done to secure a smooth surface without disturbing the stonechips.

For large areas the laying shall be in panels of maximum 25 Sq.M area. The panels shall be laid in chequered board pattern.

(d) Laying of Topping Separately on Hardened Base

The base concrete shall be prepared as stated in clause 2.3 and a slurry of neat cement applied just prior to laying the granolithic

concrete mix (1:1:2). The method of compaction etc. shall be same as for monolithic topping.

(e) Curing

Immediately after laying, the finish shall be protected against rapid drying. As soon as the surface had hardened sufficiently, it shall be kept continuously moist for at least 10 days by means of wet gunny bags or pounding of water on the surface. The floor shall not be exposed to heavy traffic during this period.

(f) Grinding

If grinding is specified, it shall start only after the finish has fully set. Clause 2.4.3 (c) shall be followed. However, the ultimate polish required shall be decided upon by the Engineer.

(g) Finishing

Where specified, sodium silicate or magnesium or zinc silico fluoride treatment shall be done. The number of coats to be applied shall be as specified. The concentration and method of application of the solutions shall be as specified in IS : 5491.

2.4.5 Patent Stone

It shall consist of an underbed and a topping laid on an already laid and matured concrete base.

(a) Thickness

The patent stone finish shall have thickness as stipulated under clause 2.4.2 (a) except that the topping shall be 6 mm thick.

(b) Mix

(i) Underbed

The mix shall be as stipulated under clause 2.4.3 (b).

(ii) Topping

The mix for the topping shall consist of 1 part cement and 1 part fine sand by volume.

(c) Laying

The Patent Stone finish, including the underbed shall be laid in alternate bays or in chequered board pattern. No panel shall be cast in contact with another already laid till the contraction of the latter has already taken place.

The maximum area of each panel shall be 3 Sq.M of which no side shall be more than 2 M long.

A cement grout shall be applied and worked into the surface to receive the finish, the underbed then laid, compacted and levelled to proper grade with a screed or float. The topping shall be applied evenly on the underbed while it is not fully set but firm enough and rolled and pressed to get full bond.

The topping shall towelled to a dense finish to the satisfaction of the Engineer. All trowel marks shall be mopped out with a soft cloth to give a clean smooth surface.

After the surface is sufficiently set, the finished floor shall be kept moist for 7 days for curing. If desired the finish shall be polished as directed by the Engineer.

2.4.6 Metallic Hardener Like "Ironite" Finish

This will consist of a topping (incorporating iron particles) to bond with concrete base while the latter is "Green".

(a) Thickness

Unless otherwise specified the metallic hardener finish shall be of 12 mm depth.

(b) Material

The hardening compound shall be uniformly graded iron particles free from non-ferrous metal impurities, oil, grease, sand soluble alkaline compounds or other injurious materials. When desired by the engineer, actual samples shall be tested.

(c) Mix

Proportion of the metallic hardener shall be as specified or as indicated by the manufacturer. However, in absence of any such direction 1 part metallic hardener shall be mixed dry with 4 parts cement, by weight. To this mixture 6 mm nominal size stone chips shall be added in proportion of 1 part cement (mixed with hardener) to 2 parts of stone chips by volume and uniformly mixed. Minimum quantity of water shall be added to make it workable.

(d) Laying

The concrete floor shall be laid as per specification "Cement Concrete" a levelled upto the required grade. The forms, if any shall remain sufficiently projecting to take the finish.

The surface shall be roughened by wire brush as soon as possible.

The finish shall be laid while the concrete underbed is still very “green” within about 3 hours of laying of the latter. The finish shall be of uniform thickness and even dense surface without trowel marks, pin holes etc. This topping layer shall be pressed firmly and worked vigorously and quickly to secure full bond with the concrete base. Just when the initial set starts the surface shall be finished \smoothened with steel trowel.

The finished floor shall be cured for 7 days by keeping it wet.

2.4.7 Mastic Asphalt Finish

This is a one layer treatment on concrete or brick base.

(a) Thickness

The thickness shall be as specified in the drawing

(b) Materials

Bitumen shall be industrial bitumen of the grades 90/15 and 75/15 conforming to IS: 702.

Mineral filler shall be dry stone dust passing through 75-micron IS Sieve.

Fine aggregate shall be crushed and graded natural lime stone or other hard-work.

Coarse aggregate shall be crushed siliceous stone or other approved aggregate 6 mm stone chips shall be used for finish upto 20 mm thick & 10 mm chips for thicker finish.

(c) Composition

Bitumen mastic shall conform to IS:1195 and shall be either brought to site in blocks weighing about 25Kg. or prepared at site. If brought in blocks, these shall be remelted in mechanically agitated mastic cookers and coarse aggregate, preferably preheated fed in successive portions until the complete change is thoroughly incorporated. At no stage during the remelting and mixing process, shall the temperature exceed 205°C.

(d) Laying

The hot mastic shall be laid on dry base surface cleaned thoroughly by wire brushing and sweeping. The mastic shall be levelled and when cooled to some extent shall be finished with a wooden float with addition of small quantity of fine sand if required. No load shall be allowed till the finish has cooled to normal temperature.

The mastic shall be laid in suitable panels of about 15 Sq.M in area each formed by formers. Succeeding panels shall be

laid overlapping the finish panel so as to melt its edges and form a continuous finish without joint.

2.4.8 Chemical Resistant in Situ Finish

Chemical resistant in situ finish shall be as epoxy resin with suitable filler material over a primer or called for in the Schedule of Items. The minimum thickness shall be 6 mm. About its performance the Engineer shall have to be fully satisfied by test results and examination of similar treatment already in existence.

The Contractor shall get it done by a specialised manufacturer, get guarantee of performance from the organisation and pass it on to the Owner in addition to his own guarantee.

2.5 TILED FINISH

These shall include finish tiles, stone slabs and similar manufactured or natural items over already laid and matured base of concrete or masonry by means of an underbed or an adhesive layer.

2.5.1 Terrazzo Tile Finish

The finish will consist of manufacture terrazo tile and an underbed.

(a) Thickness

The total thickness including the underbed shall be minimum 40 mm for floors 30 mm for walls unless otherwise specified.

The skirting, dado and similar vertical surfaces shall project out 6 mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the tiled finish, to accommodate the specified thickness shall be done.

(b) Tiles : Terrazzo

The tiles shall, unless specifically permitted in special cases be machine made under quality control in a shop. The tile shall be pressed hydraulically to a minimum of 140 Kg. per Sq.cm.

Each tile shall bear on its back permanent and legible trade mark of the manufacturer. All angles of the tiles shall be right angles all arises sharp and true, colour and texture of the wearing face uniform throughout. Maximum tolerance allowance length and breadth shall be + 1 mm and the thickness + 3 mm. Face of the tile shall be plane, free from pin holes and other blemishes.

The tiles shall be composed of a backing and topping. The topping shall be of uniform thickness not less than 10 mm. The total thickness including the topping shall be as specified but not less than 20 mm in any case.

The backing shall be composed of 1 part ordinary grey cement and 3 parts of stone chips by weight mixed with water.

The topping shall be as specified under clause 2.4.3 (b).
The tile shall be cured at the shop for at least 14 days before delivery to the site. First grinding shall be given to the tiles at the shop before delivery. Tiles shall be packed properly to prevent damage during transit and storage. The tiles must be carefully stored to prevent staining by damp, rust, oil, and grease or other chemicals.

Tiles made in each batch shall be kept and used separately so that colour of each area of the floor may remain uniform.

The manufacturer shall supply along with the tiles the grout mix containing cement and pigment in exact proportions as used in topping of the tiles. The containers for the grout mix shall be suitably marked to relate it to the particular type and batch of tiles.

(c) Mix : Underbed

The underbed for floor and similar horizontal surfaces shall be 1 part lime putty: 1 part surkhi : 2 parts coarse sand by weight mixed with sufficient water to form a stiff workable mass. For skirting and dado and all vertical surfaces it shall be about 12 mm thick and composed of 1 part cement and 3 parts coarse sand by weight.

(d) Laying

The underbed mortar shall be evenly spread and brought to proper grade and consolidated to a smooth surface. The surface shall be roughened for better bond. Before the underbed had time to set and while it is still fairly moist but firm, cement shall be hand dusted over it or a cement slurry applied and the tiles shall immediately be placed upon and firmly pressed by wooden mallet on to the underbed until it achieves the desired level. The tiles shall be kept soaked for about 10 minutes just before laying. The joints between tiles shall be as close as possible and not more than 1.5 mm wide.

Special care shall be taken to check the level of the surface and the lines of the joints frequently so that they are perfect.

When tiles are required to be cut to match the dimensions these shall be sawn and edges rubbed smooth. The location of cut tiles shall be planned in advance and approval of the Engineer taken.

At the junction of horizontal surface with vertical surface the tiles on the former shall enter at least 12 mm under the latter.

After fixing, the floor shall be kept moist and allowed to mature undisturbed for 7 days. Heavy traffic shall not be allowed.

If desired dividing strips as specified under Clause 2.4.3 (c) may be used for dividing the work into suitable panels.

(e) Grinding and Polishing

Procedure shall be same as Clause 2.4.3 (e).Grinding shall not commence earlier than 14 days after laying of tiles.

2.5.2 Chequered Tile Finish

The finish shall consist of manufactured grey or coloured cement tiles or terrazzo tiles with chequered face and an underbed laid over concrete or brick surface.

(a) Thickness

Thickness shall be same as in clause 2.5.1 (a).

(b) Tiles : Chequered

The tiles shall have chequers not less than 2.5 cm. c/c and not more than 5 cm c/c, Depth of grooves shall be not less than 5 mm. The grooves shall be uniform and straight.

The tiles shall conform to clause 2.5.1 (b) except that these may have the topping in terrazzo or plain grey cement or colour pigment added to cement as specified.

(c) Underbed

As per clause 2.5.1 (c).

(d) Laying

As per clause 2.5.1 (d).

(e) Grinding and Polishing

As per clause 2.5.1 (e) except that the tiles shall be ground and polished by hand after laying taking special care in polishing the grooves properly and uniformly.

2.5.3 Glazed Tiles Finish

This finish shall be composed of glazed earthenware tiles with an underbed laid over a concrete or masonry base.

(a) Thickness

The total thickness shall be between 20mm and 25mm including the underbed. The tile finish on vertical surface shall project out 6mm uniformly from the adjacent plaster or other wall finishes. The necessary cutting into the surface receiving the finish, to accommodate the specified thickness shall be done.

(b) Tiles : Glazed

The tiles shall be of earthenware, covered with glaze white or coloured, plain or with designs, of 150 mm x 150 mm nominal sizes and 10 mm thick unless otherwise specified. The tolerance shall be + 1.5 mm for length and breadth and + 0.5 mm for thickness specials like internal and external angles, beads, covers, cornices, corner pieces etc. shall match. The top surface of the tiles shall be glazed with a gloss or matt unfading stable finish as desired by the Engineer. The tiles shall be flat and true to shape. The colour shall be uniform and fractured section shall be fine grained in extures, dense and homogeneous. The tiles shall be strong and free from flaws like cracks, craze, specks, crawlings, etc. and other imperfections. The edge and the underside of the tiles shall be completely free from glaze and the underside shall have ribs or indentations for better anchorage with the fixing mortar.

The coloured tiles, when supplied, shall preferably come from one batch to avoid difference in colour.

(c) Mix : Underbed

The mix for the underbed shall consist of 1 part cement and 3 parts coarse sand by weight mixed with sufficient water or any other mix if specified.

(d) Laying

Same as clause 2.5.1 (d).

(e) Finishing

The joints shall be cleaned and flush pointed with white cement and cured for 7 days by keeping it wet. The surface shall be cleaned with soap or suitable detergent, washed fully and wiped with soft cloth to prevent scratching before handing over.

2.5.4 Tesserae Finish (Mosaic etc.)

This finish consists of manufactured vitreous, glass, ceramic or similar hard small pieces set in an underbed over a concrete or masonry surface, already laid.

(a) Thickness

The total thickness including the underbed shall be between 16 mm and 25 mm.

(b) Tesserae Finish

These shall usually be 6 mm thick small piece of ceramic vitreous china, tinted glass or similar hard wearing, strong and durable material in desired shapes and sizes and patterns.

The supply shall come in the desired pattern in full or sections conveniently for handling, stuck to pieces of strong thick paper on the surface to be exposed. The gum used for this purpose must be water soluble and non-staining. The sections shall be properly marked to avoid mistakes and master drawing shall be available at the site for guidance.

(c) Mix : Underbed

Same as clause 2.5.3 (c)

(d) Laying

The specification for laying if given by the manufacturer of the item shall be followed provided it is approved by the Engineer. Otherwise clause 2.5.3 (d) shall generally be followed. However, instead of grey cement the slurry shall be made with white cement to fix the panels. The paper mounted patterns in sections shall be carefully placed and pressed in position true to lines and levels. Earliest possible the paper shall be peeled off and surface examined and cleaned, joints flush pointed with white cement and cured for 7 days by keeping it wet.

2.5.5 Chemical Resistant Tiled Finish

This shall include all varieties of special tiles used for specific chemical resistance function and an underbed over already laid concrete or masonry.

(a) Tiles

The chemical resistant tiles as detailed in the Schedule of items shall be of the best indigenous manufacture unless otherwise specified and shall be resistant to the chemical described in the Schedule of Items. The tiles shall have straight edges, uniform thickness, plain surface, uniform non-fading colour and textures.

Glazed tiles if permitted to act as chemical resistant finish shall be considered under clause 2.5.3 (b).

Usually the chemical resistant tiles shall not absorb water more than 2% by weight. The tiles shall have at least compression strength of 700 Kg/cm2. The surface shall be abrasion resistant and durable.

(b) Laying

The mortar used for setting or for underbed the tiles shall be durable and strong. The grout which shall be to the full depth of tile shall have equal chemical resistant properties. Joints shall be pointed if so desired. The setting and fixing shall be according to the manufacturer's specification approved by the Engineer.

2.5.6 Rubber, Vinyl or Vinyl Asbestos Tiles Finish

This shall include various types of tiles manufactured from rubber, vinyl, etc. set with a adhesive on concrete or masonry base. An underbed may be required to secure desirable surface and grade.

(a) Thickness

The thickness of the tiles shall be mentioned in the Schedule or in drawing.

(b) Tiles

Unless otherwise desired the tiles shall be squares of approved dimensions. The tolerance in dimensions shall be 1.5mm.

The face of the tiles shall be free from porosity, blisters, cracks, embedded foreign matters or either physical defects which affect appearance or serviceability. All edges shall be cut true and square. The colour shall be confiding and uniform in appearance, insoluble in water and resistant to alkalis, cleaning agents and usual floor polishes.

Each tile shall be marked on the back legibly and indelibly with manufacturer's trade mark, the thickness, sizes, batch number and date of manufacturer.

Tiles shall be delivered securely packed and stored in clean, dry well ventilated place at a temperature near about to that the tiles shall be called upon to stand ultimately.

Adhesive to be used for sticking the tiles shall be approved by the tile manufacturer. The adhesive shall have a short drying time and long life in addition to toughness.

(c) Mix : Underbed

The underbed where required to make up the specified thickness or to give the required grade or to get the right type of surface shall be composed of 1 part like putty : 1 part cement: 4 parts coarse sand mixed with just sufficient water to make it workable.

(d) Laying

The tiles shall be kept in the room to be tiled for at least 24 hours to bring them to the same temperature as the room. For air conditioned space, the air-conditioning shall be completed before tiling is taken up.

The surface to receive this finish shall be firm even textured but not too smooth, without undulations and other deficiencies. If an underbed is laid the same shall be cured for at least 7 days by keeping it moist and then fully dried.

The surface shall be thoroughly cleaned. All loose dust particles shall be removed. Oil and grease if any shall be completely cleaned by use of detergent.

The adhesive shall be applied to fully dry surface in desired thickness uniformly. The adhesive shall also be applied to the backs and edges of the tiles and allowed to surface dry. The tiles shall be placed neatly on the surface exactly to the approved pattern and set with a suitable tool. If the edges tend to curl, weights are to be used to keep the edges down. Special care shall be taken to avoid formation of air pockets under the tiles. The joints shall be very fine. Any adhesive squeezed out through the joints shall be removed immediately.

(e) Finishing

If any adhesive mark is there on the surface a soft cloth soaked in solvent shall be used to wipe it off. The surface shall be cleaned with soft soap, dried and polished with an approved type of polish just before handing over.

2.5.7 Stone Slab Finish : Marble, Stone and Similar Fine Grained Stone

(a) Thickness

The underbed shall be minimum 12 mm and average 20 mm thick. The slabs may be 25 mm, 30 mm or 40 mm thick as specified.

(b) Stone Slab

The stone slabs shall be made from selected stock which are hard, sound, homogeneous and dense in texture and free from flaws. Angles and edges shall be true, square, and free from chipping and surface shall be plane. The slabs shall preferably be machine cut to the required dimensions.

Tolerance of 5 mm in dimensions and 2 mm in thickness will be allowed. Unless specified the slabs shall be minimum 300 mm x 300 mm.

The stone slabs shall come from specific regions and in specified quality with top surface fine chisel dressed. All sides shall also be fine chisel dressed to the full depth to allow finest possible joints.

The slabs shall be delivered to the site well protected against damages and stored in dry place under cover.

(c) Mix : Underbed

Same as clause 2.5.1 (c).

(d) Laying

The sides and top surface of the slabs shall be machine rubbed or table rubbed with coarse sand stone and washed clean before laying.

The underbed mortar shall be evenly spread and brought to proper level on the area under each slab. The slab shall be laid over the underbed, pressed and tapped down with wooden mallet to the proper level. The slab shall then be lifted and the underbed corrected as necessary and allowed to stiffen a little. Next, thick cement slurry shall be spread over the surface. The edges of the slab shall be buttered with slurry of cement, grey/white/mixed with pigment matching the colour of the stone slabs. The slab shall be gently laid and tapped with wooden mallet to bed properly to a very fine joint and to the required level. All surplus cement slurry shall be removed and the surface mopped clean with wet soft cloth. The laid finish shall be cured for 7 days by keeping it wet.

(e) Polishing, Finishing

Fine chiselling shall be done to remove the slight undulations that usually exist at the joints. The polishing and finishing shall be

done as specified under clause 2.5.1 (e). However, the joints shall be so fine in the case of stone slabs that grouting shall not be called for.

2.5.8 Stone Slab Finish : Sand Stone and Similar Coarse Grained Stone Finish

Generally clause 2.5.7 shall be followed except that the workmanship and finish shall not be fine as which are explained hereunder.

The slabs shall be rough chiseled or fine chiseled as specified. Tolerance may be allowed upto + 6 mm for rough finish, but no sharp unevenness and shall be allowed. For fine chiseling the unevenness shall be limited to 2 mm. The sides shall be chisel dressed at least to half slab depth so that the maximum deviation from straight line shall be within 25 mm. Beyond this depth the edge may be slightly splayed.

The joint thickness shall be kept limited to 5 mm in case of rough finish and 3 mm in case of fine finish unless wider joints are specified. The joints shall be grouted with white or coloured cement.

3.0 ACCEPTANCE CRITERIA

The finish shall be checked specially for:

(a) Level, Slope, Plumb as the case may be

(b) Pattern and Symmetry

(c) Alignment of joints, dividing strip etc.

(d) Colour, texture

(e) Surface finish

(f) Thickness of joints

(g) Details at edges, junctions etc.

(h) Performance

(i) Precautions specified for durability

4.0 I.S. CODES

Important relevant codes for this section:

(a)	IS : 777	:	Glazed earthenware tiles
(b)	IS : 1196	:	Code of practice for laying bitumen mastic flooring
(c)	IS : 1197	:	Code of practice for laying of rubber floors
(d)	IS : 1237	:	Cement concrete flooring tiles
(e)	IS : 1443	:	Code of practice for laying and finishing of cement concrete flooring tiles
(f)	IS : 2114	:	Code of practice for laying in situ terrazzo floor
(g)	IS : 3461	:	PVC asbestos floor tiles
(h)	IS : 4860	:	Specification for acid resistant bricks
(i)	IS : 5518	:	Code of practice for lying of flexible PVC Sheet and tile flooring.
(j)	IS : 5491	:	Code of practice for laying in situ granolithic floor topping.

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SECTION – 11

FALSE FLOORING

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	FALSE FLOORING SYSTEM
3.0	ACCEPTANCE CRITERIA

1.0 SCOPE

This specification covers supplying, installation, repairing, finishing, testing, protection and maintenance till handing over of removable free access false flooring systems consisting of an assembly of panels mounted on adjustable pedestal and supporting steel grid system to provide an under floor space.

2.0 FALSE FLOORING SYSTEM

2.1 BASE

The system shall be placed over a base of R.C.C. floor slab and with necessary grouting etc. to fix the supporting structure.

2.2 SUPPORTING STRUCTURE

The supporting structure shall comprise of fabricated jacks made out of 25 mm. dia. MS rounds having 150 mm. threads at top. This jack shall be welded to 100 mm x 100 mm x 6 mm thick MS base plate pedestal. Pedestals shall be vertically true and located at 600 mm centre to centre to conform to the size of the floor panels and shall be fixed to the RCC floor slab with ARALDITE. The jack shall be equipped with locking device to prevent loss of finished elevation. Adjustment shall be provided by the threaded rod member and elevating nut. The capital shall be of aluminium alloy die cast and shall receive cold rolled MS floor supporting channels of size 40 mm x 40 mm x 3.15 mm thickness as per drawings, both for main and cross runners. The pedestal shall be equipped with conducting grounding pad. All MS members shall be treated with steel protective paint as per drawing.

2.3 FLOOR PANEL

2.3.1 The floor panels shall be made of phenol for maldehyde bonded particle board treated with fire resistant paint as per schedule items. Size of each panel shall be 600 mm x 600 mm with all panel edges finished to a tolerance of + 0.25 mm on the diagonals. The edges of the floor panels shall be covered by 4 mm. thick rigid PVC edging. The underside of the panel

shall have 0.05 mm. thick Aluminium foil which shall be fixed to the particle board with resin-based adhesive.

2.4 STRENGTH

Each 600 mm x 600 mm floor panel must be capable of supporting an uniform minimum live load of 1220 Kg/Sq. M or a concentrated minimum load of 450 Kg. applied through a phenolic caster 75 mm in diameter and 45 mm wide, or a rolling minimum load of 450 Kg. at any point with a maximum deflection of 2 mm. The ultimate strength shall be capable of carrying a 2300 Kg. axial load without deformation of any part.

2.5 SURFACE FINISH

All removable panels shall have the top surface finished with 2 mm thick Antiatatic Vinyl Flooring bonded to the surface with adhesive as per manufacturer's specification.

2.6 SKIRTING

Skirting shall be of the same Anstistatic Vinyltiles, 150 mm. high and 2 mm. thick, completely matching with the false flooring surface and shall be fixed with the plastered wall surface as per manufacturer's specification.

2.7 INSTALLATION

All steel surface are to be protected by pointing over a primer as per schedule of items and any damage to the paint during installation shall be made good. Finished floor surface, when specified by the Engineer-in-Charge shall be protected by the Contractor with kraft paper taped and sealed at edges to prevent tearing.

Any damage to the sub floor during installation of the false flooring system shall be made good by the Contractor without to the owner.

3.0 ACCEPTANCE CRITERIA

The false flooring system shall be checked specially for:

(a) Level

(b) Alignment of joints

(c) Thickness of joints

(d) Surface finish

(e) Colour and texture

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SECTION – 12

CARPENTRY & JOINERY

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	ACCEPTANCE CRITERIA
4.0	I. S. CODES

1.0 SCOPE

This shall include supply, fitting and fixing of timber frames to doors and windows with M S holdfasts, paneled or flush doors, windows, shutters, partitions, wall paneling, pelmets, shelves, furniture, etc. as shown in drawings, including a prime coat of approved paint, varnish, or fixing of decorative plastic laminate. This shall also include the supply and fixing of all hardware and fixtures shown in drawing.

2.0 INSTALLATION

2.1 MATERIALS

2.1.1 Timber

Unless otherwise specified, all timber shall be best quality well seasoned C P teakwood free from large or loose, knots cracks or other defects. Where specified, timber shall be treated with approved wood preservative before use. Before starting the carpenters work, the Tenderer shall have the rough timber approved by the Engineer.

2.1.2 Plywood

Plywood shall be commercial quality with decorative surface veneer. Unless specifically permitted otherwise, the adhesive used in plywood shall be phenol-formaldehyde resin of B W R grade conforming to IS:848.

2.1.3 Decorative Laminated Plastic Sheets

The colour, pattern, finish and texture shall be approved by the Engineer and the bulk supply procured in sheet sizes which will ensure the least number or joints in one surface.

2.1.4 Flush Doors

Flush doors shall be hollow or solid core doors with commercial or decorative faces and hardwood edges. The core for solid core doors shall be of block board or wood particle board. Manufacturer's literature and test

certificates shall be submitted for the approval of the Engineer. The Contractor shall give a guarantee that the adhesive used is phenol formaldehyde of B W R grade, conforming to IS:848. The thickness shall be as specified in the drawing.

2.1.5 Panel Doors

Panel door shall be of teakwood shutter frame and panels of teakwood. Other considerations shall be as mentioned in item (d) above.

2.1.6 Fixtures

Fixtures for doors, windows, furniture, etc. shall be as shown on drawing.

2.2 WORKMANSHIP

2.2.1 General

The work shall be done by skilled carpenters as per details shown on drawing or instructed by the Engineer.

Framing timber and other work shall be close-fitting with proper wood joinery, accurately set to required lines or levels and rigidly secured in place. The surface of frames etc. which will come in contact with masonry after fixing, shall be given two coats of approved paint before fixing. Mastic caulking shall be done after fixing external door and window frames. Special care shall be taken to match the grain of timber or plywood which will be subsequently polished. Screwing or nailing will not be permitted to he edge of plywood and particle board. The edge of all plywood, blockboard and particle board shall be finished with teakwood lipping unless otherwise shown on drawings.

Fixing for frames and partitions shall generally be with 40 mm x 6 mm x 300 mm long M S holdfasts bifurcated at end and grouted with 1:2:4 cement concrete.

The gap between masonry and external door and window frame shall be caulked with polysulphide mastic. M S grills or guard bars shall be provided to windows where called for in the drawings.

2.2.2 Finish

All carpentry work after finishing shall be sand papered smooth. A prime coat paint shall be given after inspection of the Engineer to all surfaces other than those which shall be subsequently polished or covered with laminated plastic sheet.

2.2.3 Surface Treatment

When shown on drawings decorative ply or laminated plastic sheets shall be bonded under pressure to the surface to be finished. The adhesive used shall be of approved brand and brought to site in sealed containers. The rate of application and the length of time for which the pressure is to be applied shall be as per the manufacturer's instructions. The edge of sheets shall be protected by teak lipping or beveled as shown on drawings.

3.0 ACCEPTANCE CRITERIA

3.1 DOOR AND WINDOW FRAMES

All frames shall be square and flat at the time of delivery and shall be checked for dimensions and corner angles. After fixing they shall be on a fine vertical plane. All external door and window frames shall be caulked with mastic.

3.2 DOOR AND WINDOW SHUTTERS

Shall be of proper size, shape and design and free of warp. When fixed to frames, these shall operate smoothly without jamming and all latching or locking devices shall engage properly without undue pressure.

3.3 PARTITIONS, PANELING, PELMETS, FURNITURE, ETC

3.3.1 General

These shall conform to drawings in all details. No unsightly nailmarks etc. shall be permitted. Plywood grains shall be matched to give a uniform and pleasing appearance.

3.3.2 Partition

Shall be checked for rigidity of fixing, plumb and horizontal as well as vertical alignment.

3.3.3 Pelmets

Shall be checked for rigidity of fixing and adequate clearance of fixture.

3.3.4 Cupboard Shutters

Shall operate smoothly without jamming and locks, bolts and double ball catches shall engage securely. Single ball catches shall not be used.

3.3.5 Drawers

Shall operate smoothly and have back stops to prevent them from being pushed too far. Locks shall engage securely.

3.3.6 Loose Furniture

When placed on a level surface tables tops etc. shall be horizontal and the pieces stand stably on legs or supports.

4.0 I.S. CODES

Some of the important relevant Codes for the Section are:

(a)	IS:4021	:	Timber door, window and ventilator frames
(b)	IS: 1003	:	Timber paneled and glazed shutters
(c)	IS:2191	:	Wooden flush door shutter (Cellular and hollow core type).
(d)	IS:2202	:	Wooden flush door shutters (solid core type).

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SECTION – 13

SUSPENDED CEILING

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	MATERIAL
3.0	INSTALLATION
4.0	SHOP DRAWINGS
5.0	WORKMANSHIP
6.0	SAMPLES
7.0	ACCEPTANCE CRITERIA
8.0	I.S. CODES

1.0 SCOPE

This specification covers the furnishing of all materials, labour, tools, equipment, supervision and services necessary for incidental to the supply, installation, finishing and completion of suspended ceiling work of various profiles and at all elevations as per drawing, specification and instruction of Architect/Owner. The work shall also include providing openings in the ceiling for lighting fixtures, air conditioning diffusers etc as shown in drawing and instruction of Architect/Engineer.

2.0 MATERIAL

2.1 ALUMINIUM GRID SUSPENSION SYSTEM

2.1.1 Suspender :

Shall be fabricated from 10 dia M.S. rod angle, flast or as required to suit ceiling profile and suspension system with turnbuckle for adjustment of levels. All M.S. works shall have one coat of synthetic enamel paint over a coat of red lead primer.

2.1.2 Frame work/grid : shall be of aluminium sections as follows :

Wall angle - 25 x 25 x 1.6 mm. thick.

Main Tee - 35 x 25 x 1.6 mm. thick

Cross Tee - 25 x 25 x 1.6 mm. thick

Tees shall be jointed with adequate cleats etc.

2.2 CEILING PANEL

2.2.1 For 150C Type Un-perforated False Ceiling

(a) Un-perforated Aluminium panel of size 150mm wide x 15mm deep made up of 0.5mm thick square edged, panel length up to 6m. Panel shall be clipped to an Aluminium panel carrier of 32mm wide x 39mm

deep made of 0.95mm thick in standard length of 5m with cutouts to hold the panels in a module of 150mm. The carrier shall be suspended by means of GI suspension rod of 4mm diameter and a galvanized steel suspension spring clip at a distance of 1.5m (max.) centre to centre in both directions. The suspension rod shall be fixed to RCC ceiling / beam with suitable GI 'J' hook and nylon inserts (galvanization to be done as per IS 1367 – minimum coating 250 g/Sq.m.). The suspension spring clip shall be made of spring steel and shall have cutout and holes to fit into the carrier from one side and hold the rod hanger from another side. Providing and laying Rockloyd Resin Bonded Mineral Wool of density 48 Kg/M3 and thickness 50mm encased in black polythene.

(b) The edge profile wherever required as per architectural drawings and direction of Engineer-in-Charge shall be 'L' shaped profile manufactured out of 0.5mm thick Al-Mg Alloy of approved colour and shall be fixed to walls or panels as required.

(c) Aluminium panel splice made of 0.5mm thick, 150mm wide x 15mm deep shall be provided and installed to connect / join panels at each point.

(d) Aluminium carrier splice made 0.95mm thick, 32mm wide and 39mm deep shall be provided and installed to connect / join carriers at each point.

(e) All panels, panel splice, edge profiles shall be made of Aluminium coil coated on a continuous paint line and roll formed from corrosion resistant Aluminium Alloy AA-3105 or equivalent (Al-Mg) for higher strength and good roll forming characteristics. All carriers and their splices shall be made of Aluminium, stove enamelled alloy AA-5050 or AA-5052 or equivalent (Al-Mg) of black colour.

(f) Mode of measurement : Measurement shall be wall to wall along with the ceiling. Fascias to be measured separately without any deductions for lights, diffusers, grills etc. Nothing extra shall be paid for cutting and framing around lights, diffusers etc. as well for

providing punched holes for sprinklers, smoke detectors etc. as per requirement of architectural drawings.

2.2.2 Aluminium Tile Ceiling of 600mm x 600mm size Tiles

(a) The tile size shall be 600mm x 600mm made of 0.7mm thick bevel edged Aluminium Alloy AA-3105 sheet. The tile will be manufactured on advanced equipment, which includes several levelling stages in the manufacturing process. Tile ends will be raised with pipes and stop to ensure positive engagement into the spring to enable for demounting of individual panel. The tile sides will be sufficiently high to ensure a minimum deflection across the length of tile. All tiles will be polyester based, powder coated in white colour. Tiles shall be clipped into clip in profile of 0.5mm thick. The clip in profile shall be at a distance of 600mm center to center. The clip in profile shall be supported from RCC ceiling / beam by means of GI suspension rod shall be fixed to RCC surface by means of suitable expansion wedge hold fastener of minimum size 8mm dia 50mm long made of galvanized steel (galvanization to be done as per IS 1367 – minimum coating 250g/Sq.m.). Providing and laying Rockloyd Resin Bonded Mineral Wool of density 48 Kg/M3 and thickness 50mm encased in black polythene.

(b) Edge profile wherever required, as per architectural drawings and direction of Engineer-In-Charge shall be 'L' shaped or equivalent Aluminium profile of 23mm x 23mm and 0.7mm thick. This profile shall be used in the corner and places where the false ceiling shall be terminated.

(c) All perforated panels (if perforated tiles are being selected by the owner in place of non-perforated tiles) shall have non- woven tissue lining black coloured and glazed to the clip-in- profile side for the purpose of acoustical insulation.

(d) The clip in profile splice shall be made of 0.50mm thick GI sheet and use to connect clip in profile.

(e) Mode of measurement : Measurement shall be wall to wall along with the ceiling. Fascias to be measured separately without any

deductions for lights, diffusers, grills etc. Nothing extra shall be paid for cutting and framing around lights, diffusers etc. as well for providing punched holes for sprinklers, smoke detectors etc. as per requirement of architectural drawings.

3.0 INSTALLATION

3.1 The ceiling grid shall be suspended from structural walls slabs, beams truss structural steel etc. with suspender fabricated from M.S.rod/ angles/flasts etc. to the required level. The entire suspension system shall be of sufficient strength and rigidity to allow placing of planks over the grid for movement of maintenance personnel to attend various electrical and air conditioning installation over the ceiling and to carry ceiling panels in true level and plane without exceeding a deflecting of 1/360th of their span. All ceiling panels shall be secured in position using hold down clips of sufficient number. All joints in ceiling panels shall run straight.

The installation of ceiling system shall be strictly as per drawing.

4.0 SHOP DRAWINGS

4.1 Contractor shall prepare complete working details layout based on the conceptual layout and design of suspended ceiling and illumination and air conditioning layout shown on the drawings and obtain approval from the Architect/Owner before installation.

5.0 WORKMANSHIP

5.1 Shall be done in the best workmanlike manner by the manufacturer authorised agency in accordance with manufacturer standards and recommendations.

6.0 SAMPLES

6.1 3 (three) mock-up samples of reasonable size showing standard grid with panels and suspender etc. having desired finish, colour etc. shall be submitted to the Architect/Owner for approval before materials are Delivered at site. Installed material shall match approved samples.

7.0 ACCEPTANCE CRITERIA

Finished ceiling shall be at the correct plane and present a pleasing and uniform appearance, free from sags, warps, figures or damaged boards. Joints, exposed grids etc. shall be in true lines and symmetrically placed in manner shown on drawings. Cutouts for light fixtures, diffusers etc. shall be of exact dimensions and in exact locations.

8.0 I.S. CODES

(a) IS:2441 : Code of Practice for fixing ceiling coverings.

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SECTION – 14

METAL DOORS, WINDOWS, VENTILATORS, LOUVRES, ETC.

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	ACCEPTANCE CRITERIA
4.0	INFORMATION TO BE SUBMITTED
5.0	I S. CODES

1.0 SCOPE

The work in general shall consist of supplying and/or erecting and installing of all metal doors, windows, ventilators, louvres, glazed partitions, etc. as shown on drawings with all materials complete excluding supply of glass and glazing. The scope of work shall also include the assembly and the Owner from the store at site shall supply erection of all doors, windows, louvres, glazed partitions, etc.for which fabricated materials. Supplying and/or fixing of all door and window accessories and hardware are also included in the scope.

2.0 INSTALLATION

2.1 MATERIALS

Steel sections used for fabrication of doors, windows etc. shall be standard rolled steel sections specified in IS: 1038 and IS: 1361 or as specified in drawing and schedules.

Steel sheets for frames, shutters, louver blades etc. shall be of gauge mentioned in drawings and schedules.

Aluminium sections for fabricating doors, windows, partitions, etc. shall be extruded sections conforming to IS: 1948 and 1949 or as manufactured by Indian Aluminium Company Limited or approved equivalent. The alloy used shall conform to IS Designation HE 9-WP of IS: 733.

Hardware and fixtures shall be as specified in "Schedule of Fixtures" and the best quality from approved manufacturers shall only be used. The Tenderer shall specifically state the particular manufacturer's materials he proposes to use. "Schedule of Fixtures" is for the purpose of stating the minimum requirement and improper alignment or faulty operation due to inadequate strength of hardware or fixture shall entirely be the Contractor's responsibility

All hardware and fixtures shall be able to withstand repeated use. Door closers shall conform to IS: 3564 and shall be suitable for doors

weighing 61- 80 Kg. unless otherwise stated in schedule. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors. It shall conform to the performance requirements & endurance test stated in IS: 3564 Appendix-A.

The Contractor shall submit samples of each type of hardware to the Engineer. The approved samples shall be retained by the Engineer for comparison of bulk supply. The samples shall be returned to the Contractor towards the end for incorporation in the job.

The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general, the mastic for fixing of metal frames shall be as per IS: 1081 and/or as approved by the Engineer.

2.2 FABRICATION

2.2.1 Steel Doors, Windows, Ventilators, Louvers, etc.

(a) Door Frames

Frames shall be fabricated from 16 G sheets. They shall be mortised, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Welded construction with mitered corners shall be used. 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.

(b) Double Plate Flush Door Shutters

Door shutters shall be 45 mm thick, completely flush design and shall comprised of two outer sheets or 18 G steel sheets, rigidly connected and reinforced inside with continuous vertical 20 G stiffeners, spot welded in position at not more than 150 mm on centers.

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 as shown on drawing by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and heads, 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 bevelled or rebated. Where shown on drawing or called for in the schedule of items the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials.

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

(c) Single Sheet Door Shutters

Single sheet doors shall be made from best quality 18 G mild steel sheets and shall present a flush surface on the outside. The inside shall be stiffened with semi-tubular edge and central stiffening rail, which shall convey the lock and other furniture. The frames shall be made from best quality 16 G mild steel sheets.

Wherever required as shown on drawings, provisions for fixing glass panes, louvers, etc. shall be made.

The manufacturing shall be done as specified in clause No .2.2.1.b "Double Plate Flush Door Shutters".

(d) Sliding Doors

Sliding doors shall be either double plate or single plate construction

as called for in drawings and schedules made out of 18 gauge steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where shown on drawings or call for in the Schedule of Items, the Contractor shall make provision for openings to the door for monorail beams. Doors shall close positively to exclude rainwater from seeping in. When called for in schedule, sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.

(e) Door Threshold

Door threshold shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

(f) Steel Windows, Sashes, and Ventilators etc.

These shall conform in all respects to IS: 1038 and IS: 1361 latest editions and as shown on drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. or as shown on drawings or called for in the Schedule of Items.

All welds shall be dressed flush on all exposed and contact surfaces. Where composite unit openings are shown on drawings, the individual window units shall be joined together with requisite transoms and mullions as shown on drawings. All windows shall be outside glazed fixed with putty or metal glazing beads as shown on the drawings and/or specified under Schedule of Items. Where aluminium glazing beads are specified they shall be extruded aluminium channel 9.5 mm x 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown on drawings. Aluminium beads shall be given one coat of zinc chromate primer before fixing to windows.

2.2.2 Aluminium Door, Windows and Frames

Extruded sections shall have a minimum 3 mm wall thickness. All sections shall be approved by the Engineer before fabrication is taken up. Doors,

frames, mullions, transom etc. shall be anodized in a bath of sulphuric acid to provide a clear coating of minimum 0.6 mm thickness. The anodized materials shall then be sealed by immersing in boiling water for 15 minutes. A protective transparent coating shall be applied to the sections before shipment from the factory.

All work shall be fitted and shop assembled to a first class job and ready for erection. Shop joints shall be made to hairlines and then welded or braced by such method as will produce a uniform colour throughout the work. Work on the above, other than described, shall be carefully fitted and assembled with neat joints with concealed fasteners. Wherever possible, joints shall be made in concealed locations and on edges of doors. Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be snap fit type without visible screws and shall be of sizes to accommodate 6 mm thick glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

2.2.3 Aluminium Structural Glazing

Providing and fixing of barriered semi unitised structural glazing system at all levels through designing and selection of mullion and transoms profiles anodised (15 to 20 micron) or powder coated (50 to 70 micron), selected for their fixing on the structure depending on the structural conditions, functional, statistical requirement and should withstand the wind load criteria as per IS-875 (part-III) – 1987. System should provide proper rebate areas for air pressure compensation /water drainage at required stages. Double insulated hard coated toughened glass consist of 6mm outer single safety glass, 12mm inter space and 6mm inner clear glass panel glued onto the glass glazing frame profile selected according to the vision / spandrel panel (Aluminium Composite Panels) requirement with DC 995 structural sealant. Proper supporting element should be provided for taking care of the respective infill load and reliving in case of the glass bonding failure. (The profile sections shall be Hindalco Alupuram unit, HYDRO product or equivalent). Floor to floor height would be 4.2m approx and width of glazing supporting frame would be 1.0m approx.

2.3 SHOP COAT OR PAINT

The shop paint for steel doors, windows, etc. shall be best lead or zinc chromate primer paint from approved manufacturer. All surfaces shall be thoroughly cleaned of rust, grease, loose mill scales etc. and given one coat of shop paint. Portions like mullions, transoms etc. that will be inaccessible after assembly of units shall be given an extra coat of paint before assembly.

Where called for in the Schedule of Items all steel doors, windows, etc. shall be hot dip galvanised to give a coating weight of 1-1/2 - 2 Oz per sq. ft. One coat zinc chromate primer coat shall then be applied as shop paint.

Portions of aluminium frame which come in contact with masonry construction shall before shipment from workshop be protected with a heavy coat of alkali paint. Aluminium coming in contact with other incompatible metals shall be coated with zinc chromate primer.

2.4 HANDLING & STORAGE OF FABRICATED MATERIAL

All metal doors, windows, etc. shall be packed and crated properly before dispatch to ensure that there will be no damage to the fabricated materials. Loading into wagons and trucks shall be done with all care to ensure safe arrival of materials at site in undamaged condition.

When taking delivery of items supplied by Owner, the Contractor shall satisfy himself that the items supplied are upto the specified standard. Any defect detected shall promptly be brought to the notice of the Engineer.

All metal doors, windows, etc. shall be stored under cover in a way to prevent damage or distortion. Special care shall be taken to prevent staining of aluminum products by rust, mortar, etc.

2.5 ASSEMBLY & ERECTION AT SITE

In general, the fixing of steel doors, windows, ventilators, louvers, etc. shall conform to IS: 1081 and as shown on drawings. The Contractor shall assemble and install all steel doors, windows, sashes, fixed metal louvers, etc. including transoms and mullions for composite units in

respective places as shown on drawing keeping proper lines and levels, and in approved workman like manner to give trouble free and leak-proof installations. The installation shall be done according to the instructions of the manufacturer, and/or as approved by the Engineer. If required by the Engineer, the installation shall have to be carried out under the supervision of the manufacturer's staff. The Contractor shall take every precaution against damage of the components during installation. Necessary holes, chases, etc. required for fixing shall be made by the Contractor and made good again as per original, after installation without any extra charge.

After installation of steel doors, windows, etc. all abrasions to shop-coat of paint shall be retouched and made good with the same quality of paint used in shop coat.

All coupling mullions, transoms, frames, etc. in contact with adjacent steel and other members, shall be well bedded in mastic. The Contractor shall bring to the site the mastic cement in original sealed containers of manufacturer and shall apply it as per the instructions. For all frames supplied by either the Owner or the Contractor mastic shall be supplied by the Contractor and caulking done properly as per drawings, specifications and as per instructions of the Engineer.

Door shutters, partitions hardware fixtures etc. shall be fixed only after major equipments have been installed in rooms Wherever required nylon cords of approved quality shall be supplied along with pivoted sashes and shall be of adequate length to terminate one metre from the floor. Loose ends of cords shall end in metal or plastic pull as approved by the Engineer.

3.0 ACCEPTANCE CRITERIA

3.1 FOR FABRICATED ITEMS

3.1.1 Overall dimensions shall be within ±1.5 mm of the size shown on drawings.

3.1.2 Mullions, transoms etc. shall be in one length and permissible deviations from straightness shall be limited to ±1.5 mm from the axis of the member.

3.1.3 Door and window shutters shall operate without jamming. The clearance at head and jamb for door shutters shall not exceed 1.5 mm. For double leaf doors, the gap at the meeting stiles shall not be more than 1.5 mm.

3.1.4 Door leaves shall be undercut where shown on drawings.

3.1.5 Doors, windows, frames, etc. shall be on a true planes, free from warp or buckle.

3.1.6 All welds shall be dressed flush on exposed and contact surfaces.

3.1.7 Correctness of location and smoothness of operations of all shop installed hardware and fixtures.

3.1.8 Provisions for hardware and fixtures to be installed at site.

3.1.9 Glazing beads shall be cut with mitered corners.

3.1.10 Glazing clips, fixing devices etc. shall be supplied in adequate numbers.

3.1.11 Shop coats shall be properly applied.

3.1.12 Exposed aluminium surfaces shall be free from scratches, stains and discolouration. Anodised surfaces shall present a uniform and pleasing look.

3.2 FOR INSTALLED ITEMS

3.2.1 Installations shall be at correct location, elevation and in general on a true vertical plane.

3.2.2 Fixing details shall be strictly as shown on drawings.

3.2.3 Assembly of composite units shall be strictly as per drawings with mastic caulking of transoms and mullions, gaskets, weather strips etc. complete

3.2.4 All frames on external walls shall be mastic caulked to prevent leakage through joint between frames and masonry.

3.2.5 All openable section shall operate smoothly without jamming.

3.2.6 Locks, fasteners, etc. shall engage positively. Keys shall be non interchangeable.

3.2.7 Cutting to concrete or masonry shall be made good and all abrasions to shop paint shall be touched up with paint of same quality as shop paint.

3.2.8 Aluminium doors, windows, etc. shall be free from scratches stain or discolouration.

4.0 INFORMATION TO BE SUBMITTED

4.1 WITH TENDER

4.1.1 Names of manufacturers for doors, windows, etc.

4.1.2 Manufacturer's catalogue for all hardware and fixtures proposed to be used.

4.2 AFTER AWARD

4.2.1 Before starting fabrication of all metal doors, windows, etc. the Contractor shall submit detailed fabrication drawings to the Engineer for approval. The fabrication shall be started only after approval of drawings.

4.2.2 He shall submit a programme of work to be done for the approval of the Engineer.

4.2.3 Before bulk supply, he shall submit for the approval of the Engineer samples of all bought out items and samples of each type of fabricated items. The samples shall be retained by the Engineer for comparison of bulk supply and returned to the Contractor towards the end for final incorporation in the job.

5.0 I.S. CODES

Following are some of the important I.S. Codes as relevant to this section:

(a) IS: 1038 : Steel doors, windows and ventilators

(b) IS: 1361 : Steel windows for industrial buildings

(c) IS: 1948 : Aluminium doors windows and ventilators

(d) IS: 1949 : Aluminium windows for industrial buildings

(e) IS: 4351 : Steel doorframes

(f) IS: 1081 : Code of practice for fixing and glazing of (steel and aluminium) doors, windows, And ventilators. Metal

VOLUME VI-B

SECTION – 15

GLASS AND GLAZING

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	ACCEPTANCE CRITERIA
4.0	I.S. CODES

1.0 SCOPE

The work in general shall consist of supplying and fixing all glass and glazing including all clips, putty, mastic cement etc. wherever required as shown on drawings and specifications, supply of metal glazing beads and neoprene gaskets shall not be included in this scope.

This shall also include the fixing of all glass and glazing supplied by the Owner at his site stores.

2.0 INSTALLATION

2.1 GENERAL

The Contractor shall supply and install all glass and glazing as required for various doors, windows, sashes, ventilators and fixed louvres, miscellaneous glazing and partitions, unless otherwise stated from approved manufacturer having uniform refractive index and free from flaws, specks and bubbles. The glass shall be brought to site in the original packing from the manufacturer and cut to size at site.

2.2 MATERIALS

2.2.1 Glare reducing or heat absorbing glass shall be of approved manufacturer and special care shall be taken to grind smooth and round off the edges before fixing.

2.2.2 Glass shall be float glass of required thickness and shall be clear or tinted as indicated.

2.2.3 Wired glass shall be thick rolled glass with centrally embedded 42g. Wire mesh of Georgian type. This may be of clear or coloured glass, as shown on drawings.

2.2.4 Obscure glass shall have a cast surface in one side.

2.2.5 Coloured and figured glass shall be as per approved sample.

2.2.6 In general, the putty shall conform to IS : 400 and be of best quality from approved manufacturer. It shall be brought to site in the manufacturer's original packing. Quick setting putty glass is used where it shall be non-setting type.

2.2.7 EPDM gaskets with snap-fit glazing beads shall be fixed as per manufacturer's instructions and shall sit snugly against glass to give a leak proof installation.

2.2.8 Float glass

2.2.9 Double glazing

2.3 GLAZING, SETTING AND FINISH

All glazing clips, bolts, nuts, putty, mastic cement etc. as required shall be supplied by the Contractor.

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

Glass panes shall be set without springing, and shall be bedded in putty and back puttied, except where moulding or gasket are specified, putty, mastic cement etc. shall be smoothly finished to the even line and figured glass shall be set with smooth side out.

After completion of glazing work, the Contractor shall remove all dirt stains, excess 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.

3.0 ACCEPTANCE CRITERIA

3.1 All installation 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 underground edges.

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

3.3 All glass shall be embedded in mastic or fixed by neoprene gaskets to give a leak proof installation.

3.4 At completion, the panes shall be free from dirt, stains, excess putty etc. to the complete satisfaction of the Engineer.

4.0 I.S. CODES

Following are some of the important I.S. Codes relevant to this Section:

(a) IS : 3548 : Code of practice for glazing in building.

(b) IS:1083 : Code of practice for fixing and glazing metal doors, windows & ventilators.

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SECTION – 16

ROLLING STEEL SHUTTERS / GRILLS

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	ACCEPTANCE CRITERIA
4.0	I. S. CODES

1.0 SCOPE

This specification covers the design, supply of materials, fabrication, delivery and erection of Rolling Shutters/Grills with motor drive and/or manual operation including all accessories as hereinafter specified.

2.0 INSTALLATION

2.1 COMPONENTS

2.1.1 Slats for rolling shutters shall be made from tested bright cold rolled, annealed M.S. strips, not less than 0.9 mm thick for shutters upto 4.5 M wide and not less than 2.25 mm thick for shutters 5.5 M wide and above, machine rolled at 75 mm rolling centres, interlocking with each other. The profile will be such as to prevent excessive deflection under specified wind load.

2.1.2 Rolling grills shall be constructed out of 6 mm dia. rods at 35 mm on centres running horizontally flexible connected with vertical links spaced not more than 200 mm centres. Alternatively, rolling grills shall be made from perforated slats of approved design reinforced with 6 mm dia rods.

2.1.3 End locks shall be heavy type M.C.I./C.I. and shall be provided at each end of alternate slats unless specified otherwise in the Schedule.

2.1.4 Bottom bars shall be finished with two angles not less than 6 mm thick for external shutters. When shown on drawings, a flexible weather strip shall be applied to make tight contact with the floor.

2.1.5 Guides shall be of such depth as to retain the shutter under a wind pressure of 100 Kg/Sq.M or as specified in Schedule.

2.1.6 Shafts shall be of steel pipe of sufficient size to carry the torsion load with a maximum deflection of 1/360th of span.

2.1.7 Grease packed ball bearings or bushings shall be provided for smooth trouble free operation.

2.1.8 Hoods shall be formed of not less than 20 gauge steel, suitable reinforced to prevent sag.

2.1.9 Locks shall be slide bolt and hasp, or cylinder lock operable from one or both sides. Provision securing hand chain with pad-lock, provision for removable handle for hand cranks etc. shall be made as described in Schedule or as described by the Engineer.

2.1.10 Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of 0.3 metres per second. In addition to the gear motor each standard power unit shall include a magnetic brake, a reversing starter with built-in overload protection, a geared limit switch and one push button station located inside the building unless otherwise stated drawing.

It is desirable that the bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction.

2.1.11 Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection.

2.1.12 Reduction gears shall be high strength gray cast iron, machine moulded from machine out patterns.

2.2 MANUALLY OPERATED SHUTTERS/GRILLS

Manually operated shutters shall be easily operable by one person. The speed of operation shall be about 1.3 metres per second. In general, manually operated shutters shall be push pull type for openings upto 9 Sq. metre in area. Larger shutters shall be either chain and gear operated or crank and gear operated. The crank handle shall be removable. All shutters shall be lockable from one or both sides as described as desired by the Engineer.

2.3 POWER OPERATED SHUTTERS/GRILLS

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

2.4 SHOP COAT

Shutters shall be painted with one coat of red lead or zinc chromate primer. Where specified, doors shall be galvanized and subsequently painted one coat of zinc chromate for adhesion of field coat.

2.5 ERECTION

Door shall be installed by the manufacturer or his authorised representative and all work shall be as per manufacturer's instructions. Any drilling or cutting to concrete, masonry etc. shall be made good after erection of shutters and all abrasion to shop coat shall be touched up. All electrical work shall be in strict accordance with the latest Indian Electricity Rules.

3.0 ACCEPTANCE CRITERIA

3.1 SHOP INSPECTION

After completing the manufacture of the different components of the rolling shutter, an arrangement for shop inspection by the Engineer shall be made to check the conformity with approved shop drawings.

3.2 FIELD INSPECTION

After installing the shutters, the Contractor shall test the performance of the shutter in the presence of the Engineer. The doors shall be smoothly operable under all ambient conditions. All control and locking devices shall give fault-free performance.

3.3 GUARANTEE

The Contractor shall give one year's guarantee for the successful operation of the shutters. This shall be supported by a separate and unilateral guarantee from the manufacturer of the shutters.

4.0 I.S. CODE

(a) IS: 6248 - Metal rolling shutters and rolling grills

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SECTION – 17

MISCELLANEOUS METAL

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	ACCEPTANCE CRITERIA
4.0	I.S. CODES

1.0 SCOPE

This specification shall generally be read in conjunction with section IV and V

This shall include supply, fabrication and erection of miscellaneous metal items of light nature in gates, grills, balcony and stair handrails particulars, structural mullions and transoms, ladders hangers masonry anchors, shelf angles, anchor bolts, fasteners, etc. as shown on drawing or as instructed by the Engineer. The above items shall be of fabricated or cast M.S/Aluminium/Brass, cast iron, M.S. and galvanised M.S. Sheets, aluminium sheets, expanded metal, wire mesh etc. as shown on drawings and/or described.

2.0 INSTALLATION

2.1 FABRICATION/CASTING

2.1.1 General

All work shall be done according to approved shop drawings. All workmanship shall be equal to the best practice in modern structural or foundry shop.

2.1.2 Shop Connections

(a) All shop connections shall be riveted or welded except when noted otherwise on drawings.

(b) Welding of steel shall be done in accordance with the IS: 816. Use of metal arc welding for general construction in Mild Steel.

(c) Welding of aluminium shall be done in accordance with IS: 2812, Arc welding of Aluminium and Alloys, Special care shall be taken to grind smooth all welded surface that shall remain exposed to view. Welds shall be electrically continuous if so required by the Engineer.

2.1.3 Shop Coat

Before leaving the shop, all metal work shall be thoroughly cleaned by effective means of all loose mill/ scale, rust and foreign matter. Except where encased in concrete, all steelwork shall be given one coat of approved metal protective paint, applied by brush thoroughly and evenly, well worked into joints and other open spaces. All paint shall be applied to dry surfaces. Steel work shall be galvanised or galvanized and painted with a coat of zinc chromate primer. Aluminium surfaces which shall come in contact with masonry shall be given one coat of zinc chromate primer.

2.2 ERECTION

2.2.1 Bracing

The Contractor shall provide all necessary temporary guys and braces to ensure alignment and stability of the members and to take care of all loads to which the structure may be subjected including erection of equipment and operation of the same.

2.2.2 Temporary Bolting-Up

As erection proceeds the Contractor shall plumb up and level all members and shall securely bolt up to take care of all dead load, wind load and erection stresses. Wherever piles of materials, erection equipment or other loads are carried during erection, proper provision shall be made to take care of the stresses resulting from the same.

2.2.3 Turned Bolt

For field connections where bolting is specified, holes for the turned bolts may be reamed in the field, if required. All drilling or reaming for turned bolts shall be done after the parts to be connected are assembled.

2.2.4 Welding

Where specified on drawings, welding shall be done in accordance with IS:

816 for steel and IS: 2812 for Aluminium and Alloys.

2.2.5 Cutting and Fitting

No cutting of sections, flanges, webs of angles shall be done without the approval of the Engineer. Where indicated on the drawings, holes, cuttings, etc. shall be provided as required for installation, to the work by the other Contractors. No additional holes or cuttings, than those shown on drawings, shall be made without the approval of the Engineer.

2.2.6 Drifting

Correction of minor misfits and a reasonable amount of reaming and cutting of excess stock from rivets may be permitted. For this, light drifting may be allowed to draw holes together. Twist drills shall be used to enlarge as necessary to make connections. Reaming that weakens the members or makes it impossible to fill the holes properly or to adjust accurately after reaming shall not be allowed.

Any error in shop work which prevents the proper assembling and fitting of parts by moderate use of drift pins or a moderate amount or reaming and slight chipping and cutting shall immediately be called to the attention of the Engineer and approval of the method of correction obtained. The use of cutting torches to enlarge or alter rivet holes shall not be permitted.

2.2.7 Grouting

All bearing plates, loose lintels and beams, etc. shall be set to proper grade and level by the Contractor and the Engineer's approval obtained before proceeding with the grouting. Grouting shall be done in 1:1.5:3 or 1:1- 1/2:3 concrete with 6 mm down stone chips.

2.2.8 Anchor Bolting

When shown on drawings, the miscellaneous metal items shall be fixed to concrete by case hardened and drawn carbonizing steel expander nut and bolt. The Contractor shall submit the manufacturer's literature

showing the average pull out and average shear values for bolts of various sizes. The bolts shall be fixed strictly as per the manufacturer's instructions.

2.2.9 Pipe Joints

M.S. Pipes shall be joined by threaded sockets or by welding. Cast iron pipes shall be socket and spigot jointed and caulked with hemp and molten lead.

2.2.10 Spot Painting

All field rivets and bolts and also any serious abrasion to shop paint shall be spot painted with the same materials as used for the shop paint.

2.2.11 Making Good

All cutting to concrete or masonry shall be made good to the satisfaction of the Engineer.

3.0 ACCEPTANCE CRITERIA

3.1 All items shall be of correct shape, size, weight etc. shown on drawings.

3.2 For installed items, the tolerances shall be follows :

3.2.1 Permissible deviation from straightness - 1 in 1000.

3.2.2 Seats, stiffener connections etc. Shall be as per approved drawings and shall not interfere with architectural clearances.

3.2.3 All castings shall be free from blow holes, cracks and other blemishes.

4.0 I.S. CODES

(a) IS : 226 : Structural Steel (Standard Quality).

(b) IS:800 : Code of practice for use of structural steel in general building construction..

(c) IS : 816 : Use of metal arc welding for general construction in mild steel.

(d) IS : 2812 : Arc welding of Aluminium and Alloys.

(e) IS : 3150 : Hexagonal Wire Netting.

(f) IS : 4948 : Welded steel wire fabric for general use.

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SECTION – 18

PAINTING, WHITE WASHING AND POLISHING ETC

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	ACCEPTANCE CRITERIA
4.0	I.S. CODES

1.0 SCOPE

This specification covers painting, white washing, varnishing, polishing etc. of both interior and exterior surfaces of wood work, masonry, concrete plastering, plaster or Paris, Punning false ceiling, structural and other miscellaneous steel items, rain water down comer, floor and roof drains, soil, waste and service water pipes, and other ferrous and non-ferrous metal items as shown on drawings, or as directed by the Engineer.

Copper, bronze, chromium plate, nickel, stainless steel, aluminium and monel metal shall generally not be painted or finished except if otherwise specified.

The painting Contractor shall inspect the work of others prior to the application of paint. If surface to be finished cannot be put in suitable condition for painting by customary preparatory methods, the painting contractor shall notify the Engineer in writing or assume responsibility for and rectify unsatisfactory finishing that results.

Before commencing painting, the painting Contractor shall obtain the approval of the Engineer in writing regarding the schedule of work to minimize damage, disfiguration or staining by other trades. He shall also undertake normal precautions to prevent damage, disfiguration or staining to work of other trades or other installations.

2.0 INSTALLATION

2.1 MATERIALS

Materials shall be highest grade products or well-known approved manufacture and shall be delivered to the site in original sealed containers, bearing brand name, manufacturer's name and colour shade, with labels intact and seals unbroken. All materials shall be subject to inspection, analysis and approved by the Engineer. It is desired that materials of one manufacturer only shall be used as far as possible & paint or one shade is obtained the same manufacturing batch. All paint shall be subject to analysis from random samples taken at site from painter's bucket, if so desired by the Engineer.

All prime coats shall be compatible to the material of the surface to be finished as well as to the finishing coats to be applied.

All unspecified materials such as shellac, turpentine or linseed oil shall be of the highest quality available and shall conform to the latest IS standards. All such materials shall be made by reputable recognised manufacturers and shall be approved by the Engineer.

All colours shall be as per painting schedule and tinting and matching shall be done to the satisfaction of the Engineer. In such cases, where samples are required, they shall be executed in advance with the specified materials for the approval of the Engineer.

2.1.1 White Washing

Shall be done from pure shell lime or fat lime, or a mixture of both as instructed by the Engineer; and shall conform to IS:712 latest edition. Samples of lime shall be submitted to the Engineer for approval, and lime as per approved sample shall be brought to site in unslaked condition. After slaking, it shall be allowed to remain in a tank of water for two days and then stirred up with a pole, until it attains the consistency of thin cream. 100 grams of gum to 6 litres of white wash water and a little quantity of indigo or synthetic ultramarine blue shall be added to the lime.

2.1.2 Dry distemper

Shall be made from suitable pigments, extenders, lime proof tinters, water soluble binders etc. and shall conform to IS:427.

2.1.3 Oil Bound Washable Distemper

Shall be of oil emulsion type, containing suitable preservatives and shall conform to IS: 428.

2.1.4 Waterproof Cement Paint

Shall be made from best quality white cement and lime resistant colours with accelerators, waterproofing agents and fungicides. The paint shall

conform to IS: 5410.

2.1.5 Acrylic Emulsion Paint

Shall be water-based acrylic copolymer emulsion with retile titanium dioxide and other selected pigments and fungicide. It shall exhibit excellent adhesion to plaster and cement surface and shall resist deterioration by alkali salts. The paint film shall allow the moisture in wall to escape without peeling or blistering. The paint, after it is dried, shall be able to withstand washing with mild and water without any deterioration in colour, or without showing flaking, blistering or peeling.

2.1.6 Synthetic Enamel Paint

Shall be made from synthetic resins and drying oil with rutile titanium dioxide and other selected pigments to give a smooth, hard, durable and glossy finish to all exterior and interior surfaces. White and pastel shades shall resist yellowing and darkening with aging. The paint shall conform to IS: 2932 and IS: 2933.

2.1.7 Aluminium Paint

Shall be in two pack containers and shall resist weathering. The paint shall conform to IS: 2339.

2.1.8 Shall be best quality alkyd varnish suitable for brushing over the tint of paint or light natural wood and shall not darken or yellow with age.

2.1.9 French Polish

Shall be made from best quality shellac, denatured spirit and other suitable alcohol soluble ingredients and made by a well known approved manufacturer. The material shall conform to IS:348.

French polish shall not be used on bare wood. It shall only be used as finishing coat on wood after the wood is pre-treated with liquid wood filler conforming to IS: 345 is applied and rubbed out.

2.2 STORAGE

The Contractor shall arrange for safe and proper storage of all materials and tools. The storage space if allotted within the building shall be adequately protected from damage, disfigurement & stains. Paint shall be kept covered at all times and mixing shall be done in suitable containers. All necessary precautions shall be taken by the Contractor to prevent fire.

2.3 PREPARATION OF SURFACE

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

2.3.1 Wood

All surfaces shall be free from dirt and loose or peeling paints. The surface shall be rubbed down smooth. All nails & screws shall be sunk below the surface and filled with putty after applying an under coat. Small knots that do not justify cutting and sap streaks shall be covered with minimum 2 coats of pure shellac coating applied thinly & extended 25 mm beyond the area. All large, loose or resinous knots shall be removed and filled with sound wood. All work shall be done as per IS: 2338.

2.3.2 Masonry, Concrete and Plastered Surface

Surface shall be free from all oil, grease, efflorescence, mildew, loose paint or other foreign and loose materials. Masonry cracks shall be cleaned out and patch filled with mortar similar to the original surface and uniformly textured. Where this type of re- surfacing may lead to the finishing paint being different in shade from the original surfaces, the resurfaces area shall be treated with minimum one coat of cement primer, which should be continued to the surrounding area for a distance of minimum 100 mm.

Surface with mildew or efflorescence shall be treated as below:

(a) Mildew

All mildewed surfaces shall be treated with an approved fungicide such as ammonia cal wash consisting of 7g of copper carbonate dissolved in 80 ml. liquor ammonia and diluted to 1 litre with water, or 2.5 percent magnesium silicofluoride solution and allowed to dry thoroughly before paint is applied.

2.3.3 Metal

All metal surfaces shall be absolutely clean, dry and free from wax, grease or dried soap films. In addition, all steel and iron surfaces shall be free from rust, surfaces shall be cleaned by mechanical power tools to remove mill scales unless otherwise approved by the Engineer for exposed chemical resistant paints, surfaces shall be blast cleaned to near white metal. All galvanised iron surfaces shall be pre-treated with a compatible primer according to the manufacturer's direction. Any abrasion in shop coat shall be touched up with the same quality of paint as the original coat.

2.4 APPLICATION

2.4.1 General

The method of application shall be as recommended by the manufacturer. In case of selection of special shades and colour (not available in standard shades) the Contractor shall mix different shades and prepare test panels of minimum size 1 meter square as per instruction of the Engineer and obtain his approval prior of application of finishing paints.

Proper tools and implements shall be used. Scaffoldings 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 labours in a workmanlike 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 the surfaces to moisture, shall only be done after the moisture on and below the surface has dried out.

All coats shall be thoroughly dry before succeeding coat is applied. Coats of painting as specified are intended to cover surfaces perfectly. In case the surface is not covered properly by applying the specified number of coats, further coats shall be applied by the Contractor when so desired by the Engineer.

All primers and undercoats shall be tinted to approximate the colour of the finishing coats. Finished coats shall be of exact colour and shade as per approved samples and all finish shall be uniform in colour and texture. All parts of mouldings and ornaments shall be left clean and true to finish.

Painting on ferrous metal surface shall be done as per IS: 1477 (Part 1 & 2). The total dry thickness of the film should not be less than 120 micron.

2.4.2 White Washing

The surface where white washing is to be applied shall be cleared of all loose materials and dirt. All holes and irregularities of the surface shall be filled up with lime putty and shall be allowed to dry up before application of the lime solution.

One coat of whitewash shall consist of one stroke from top downwards, another from bottom upwards over the first stroke and another from left to right before the previous one dries up. Second coat shall be applied and in case the Engineer feels that one or more coats are required. No brush marks shall show on the finished surface.

2.4.3 Dry Distemper

New plastered surface shall be allowed to dry for at least two months. New lime or lime cement plastered surface shall be washed with a solution of 1 part Vinegar to 12 parts water or 1:50 sulphuric acid solution and for

24 hours after which the wall shall be thoroughly washed with clean water. For cement plastered surface, the surface shall be washed with a solution of 100 gms. Of zinc sulphate to 1 litre of water and then allowed to dry.

Dry distempering shall be done as per manufacturer's instruction. In applying the distempers the brush should first be applied horizontally and immediately crossed off perpendicularly. Brushing shall not be continued too long as otherwise brush marks may result.

2.4.4 Oil bound washable distemper

The distemper shall be applied after surface is primed with an alkali resistant primer, and followed by minimum two coats of oil bound washable distemper all as per

Manufacturer’s instruction.

2.4.5 Waterproof Cement Paint

Surface to be coated with cement paint shall be washed and brushed down. As soon as the moisture has disappeared, the surface shall be given one coat of paint. Care shall be taken so that the paint does not dry out too rapidly. After 4 to 6 hours, the water shall be sprinkled over the surface to assist curing and prevent cracking. After the first coat has dried (24 to 48 hours) the second coat shall be applied in a similar manner. The finished surface shall be kept moist by occasional sprinkling with water for seven days after painting.

2.4.6 Acrylic Emulsion Paint

Lime gauged cement plastered surfaces shall not be painted for at least one month after plastering. A sample patch shall be painted to check alkali reaction if so desired by the Engineer. Painting shall be strictly as per manufacturer's specification.

2.4.7 Synthetic Enamel Paint

Shall be applied on properly prime red surface. Sub sequential coat shall not be applied till the previous coat is dry. The previous shall be lightly sand papered for better adhesion of subsequent coats.

2.4.8 Aluminium Paint

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction. When more than one coat of paint is required or indicated, the next coat shall only be applied after the previous coat become hard dry.

2.4.9 Clear Synthetic Varnish

The paint, supplied in two pack containers shall be mixed and applied strictly as per manufacturer's direction

The Varnish shall be applied on wood surface after (a) filling; (b) staining & (c) sealing operations are carried out. The application of a combination of filler and stain shall not be permitted.

For the finishing coats of varnish, the surface shall be allowed to dry and be rubbed down lightly, wiped off and allowed to dry. Careful attention to cleanliness is required for varnishing. All dust and dirt shall be removed from the surface as well as from the neighbourhood. Damp atmosphere and draughts shall be avoided, and exposure to extreme heat or cold & dampness shall not be allowed.

The varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with light strokes to avoid frothing. It shall be allowed to flow on while the next section is being laid on excess varnish shall then be scrapped off the brush and the first section be crossed, recrossed and then laid off lightly. The varnish once it has began to set, shall not be retouched. In case of any mistake in application, the varnish shall be removed and the work started afresh.

The varnish shall be minimum of two coats, with the first coat being a flatting varnish. This shall be allowed to dry hard and be flatted down,

before applying the next coat. Sufficient time must be allowed between coats to get a hard dry surface before next coat is applied. All work shall be as per relevant IS Code.

2.4.10 French Polish

All unevenness of the surface shall be rubbed down to smoothness with sand paper and the surface shall well dusted. The pores in the wood shall be filled up with a paste of whitening in water or methylated spirit with a suitable pigment like burnt siemma or umber.

After application of the filler paste, the French polish shall be applied with a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles so that the polish is sparingly but uniformly applied over the entire area to give an even surface. A trace of linseed oil may be used on the pad for case of application. The surface shall be allowed to dry before further coats are applied in the same manner. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions to leave the finished surface with a uniform texture and high gloss.

2.4.11 Chemical Resistant Paint

For chemical resistant paints, epoxy, chlorinated rubber or vinyl butyl paint system shall be used manufacturer's recommendation regarding the paint system exposed to moderately severe corrosive condition and subject to acid/alkali spillage and fumes, shall be followed.

2.4.12 Epoxy coating/painting

On the clean surface of concrete after properly drying of the following system is to be adopted as per manufacturers' specification:

One coat of primer of following proportion to be applied over clean and dried concrete surface by brush application.

ARALDITE GY 250 - 100 Parts by weight

HARDENER HY 840 - 50 Parts by weight

Over the primer, the uneven surface of concrete should be filled with levelling putty as mentioned above. The cost of putty is included in the item rate without fixing prior limit to consumption of putty. Two top coats of the protective treatment to be applied over the prepared smooth surface in the following proportion.

(a)	ARALDITE GY 250	:	100 Parts by weight
(b)	HARDENER HY 830	:	45 Parts by weight
(c)	HARDENER BY 850	:	15 Parts by weight
(d)	SILICA FLOUR	:	20 Parts by weight
(e)	FLOW CONTROL AGENT	:	2 Parts by weight

Pigment may be added if desired by Engineer. The first top coat is applied over the primer and is left to reach a tack free state. At this stage, the final top coat is applied.

2.5 PROTECTION

Furniture and other movable objects, equipments, fittings and accessories shall be moved, protected and replaced upon completion of work. All stationary equipments shall be well covered so that no paint can fall on them. Work finished by other agencies shall be well protected. All protections shall be done as per instructions of the Engineer.

2.6 CLEANING UP

In addition to provisions in general conditions the Contractor shall, upon completion of painting etc. remove all marks and make good surfaces, where paint has been spilled, splashed or splattered, including all equipments, fixtures, glass, furniture, fittings etc. to the satisfaction of the Engineer.

3.0 ACCEPTANCE CRITERIA

3.1 All painted surfaces shall be uniform and pleasing in appearance.

3.2 All varnished surfaces shall be of uniform texture and high glossy finish.

3.3 The colour, texture etc. shall match exactly with those of approved samples.

3.4 All stains, splashes and splatters of paints and varnishes shall be removed from surrounding surfaces.

4.0 I.S. CODE

Important relevant IS Codes for this Sections are listed below :

(a)	IS:348	:	Specification for French Polish
(b)	IS:427	:	Specification for Distemper, dry colour as required.
(c)	IS:428	:	Specification for Distemper oil emulsion, colour as required.
(d)	IS:1477	:	Code of Practice for painting of ferrous (I&II) metal in buildings.
(e)	IS:2338	:	Code of Practice for finishing of wood (I&II) and wood based materials.
(f)	IS:2339	:	Specification for Aluminium Paints for general purposes in dual containers.
(g)	IS:2395	:	Code of Practice for painting concrete, masonry and plaster surface.
(h)	IS:2932	:	Specification for enamel, synthetic, exterior, type-I.
(i)	IS:5410	:	Specification for cement paint, colour as required.

VOLUME VI-B

SECTION – 19

ROOF WATER PROOFING, INSULATION AND ALLIED WORKS

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	ACCEPTANCE CRITERIA
4.0	I.S.CODES & STANDARDS

1.0 SCOPE

This specification covers furnishing, installation, repairing, finishing, curing, testing, protection, maintenance till handing over of roof water-proofing, insulation and allied work for buildings and at locations covered under the scope of the Contract.

2.0 INSTALLATION

2.1 GRADING UNDERBED

The surface to receive the underbed shall be roughened and thoroughly cleaned with wire brush and water. Oil patches if any shall be removed with detergent. The surface shall be soaked with water and all excess water removed just before laying of the underbed.

The underbed shall not be laid under direct hot sun and shall be kept in shade immediately after laying so as to avoid quick loss of water from the mix and separation from the roof surface. The underbed shall be cured under water for at least 7 days.

The underbed shall be laid to provide an ultimate run off gradient not less than 1 in 120 and as directed by the Engineer. Upto an average thickness of 25 mm the underbed shall usually be composed of cement and sand plaster. For higher thickness the underbed shall be made with cement concrete.

The underbed shall be finished to receive the waterproofing treatment direct or insulation as the case may be the grading plaster shall be average 25mm thick maximum. It shall consist of cement and coarse sand in the ratio 1:4 nominal by volume. The same and cement shall be thoroughly mixed dry and them water added. Each batch of mix shall be consumed before the initial set starts

The plaster shall be fully compacted to the desired grade in continuous operation. The surface shall be even and reasonably smooth.

2.2 CONCRETE

The concrete shall be used where the sub grade is more than average 25mm thick. It shall consist of cement concrete 1:2:4 nominal mix by volume with 12mm down stone chips and coarse sand. The aggregate shall be mixed dry and minimum quantity of water shall be added to make the mix workable. The mix shall be laid to proper grade, fully consolidated and surface shall be smooth and even.

2.3 INSULATION

The Tenderer shall along with the tender send specification of insulating materials he proposes to use and the proposed method of laying. Before bulk supply, the contractor shall send samples of insulating material to the Engineer, and after approval of the samples, the Contractor shall procure and transport the bulk material to the site. Whenever asked by the Engineer, the Contractor shall furnish test certificates from testing laboratory on the insulating and other properties of the materials.

After laying the insulation the surface shall be made ready as required to receive the waterproofing treatment. If any plastering is used it shall be not leaner than 1:4 cement sand by volume and not thinner than 12mm and it shall be cured for seven days.

2.3.1 Foam Concrete

This shall be of light weight foam concrete of average 75 mm thickness or as specified or as shown on drawings. This may be laid in situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m degree C. The weight of the insulating material shall be from 0.3 to 0.5 gm/cm.

Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer. The foam concrete laid shall be sufficiently strong to make the usual work load and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, samples from each batch of the mix shall be kept for test if so desired by the Engineer.

2.3.2 Expanded Polystyrene Blocks

The expanded polystyrene block insulation shall be fire retardant quality and shall have a maximum thermal conductivity of 0.026 KCl m/m degree C. It must be strong enough to withstand without deformation the workload and standard loads expected on the roof.

The Contractor shall lay the expanded polystyrene block as per manufacturer's approved specification. Only specifically experienced workers shall be used for this work. If the Engineer is not satisfied about the efficiency of the workers the Contractor shall have to secure manufacturer's supervision.

Either of above items (cl. No. 2.3.1 or 2.3.2) can be adopted subject to approval of engineer.

2.4 FILLETS

Fillets at junction of roofs and vertical walls shall be provided with the same insulating material as provided for the main roof insulation. The fillets shall be 150 mm x 150 mm in size unless otherwise shown on drawings or instructed by the Engineer.

Where there is no insulation over roof slab, fillets shall be cast-in-situ cement concrete (1:2:4) nominal mix by volume.

2.5 WATER PROOFING BY EPOXY RESIN BASED APPLICATION

Exposed surfaces of cement concrete, lime concrete or brickwork to be treated for waterproofing by the resin based application shall be thoroughly cleaned and the epoxy resin based material to be applied as directed by the manufacturer. The material shall not have any adverse effect on the surface on which it is applied and must stick to it uniformly to make a strong durable bond. It shall not be affected by short duration from fire, sun, light traffic. The application shall be resistant to growth of fungus and

proof against saltpetre action. If desired by the Engineer, a sample shall be prepared in advance and tested for water proofness for 48 hours under 300 mm depth of standing water. The Contractor shall arrange the demonstration by providing free the materials and labours for the application.

2.6 FLASHING

Unless otherwise stated flashing shall be done in the same way as the water proofing except that the last layer, instead of being finished with pea- sized gravel, shall be finished with two coats of bituminous primer. The flashing shall be extended up the vertical surfaces as shown on drawing. The flashing shall end in grooves in vertical walls. The grooves shall be at least 65 mm deep and caulked with waterproof of mastic cement. The minimum overlap with horizontal roofing felt shall be 100 mm.

Where specified on drawings or directed by the Engineer, metal flashing shall be provided. The metal flashing shall be done as shown on the drawings. The materials shall be 18g or 22g G.I. sheets, as specified on the drawings and/or as directed by the Engineer.

2.7 ELASTROMERIC MEMBRANE

2.7.1 Primer Coat

It shall consist of polyurethane (P.U.) or any other equivalent material. Primer coat shall be a special blend of moisture curing urethane pre-polymers in solvent. A single coat of this primer shall be applied by brush /spray with airless pray equipment over the prepared bed as an adhesion coat with an application rate of 6-8 q.m per litre depending on the surface porosity.

The primer shall be allowed to dry for a minimum period of 2 to 4 hours time before the successive finishing coats of P.U. liquid membrane are applied. In any case successive finishing coat shall be applied within 24 hours.

The substrate shall be properly prepared by removing all loose materials by igourous brushings, fungal growth with proprietary ungitide as recommended. Priming coat shall not be applied to damp substrate.

2.7.2 Finishing Coats

The finishing coats shall consist of two successive liquid coatings of high solid ontent urethane pre-polymers material to form an elastomeric embrane. Application shall be with brush or spray to form an uniform jointless elastomeric membrane. The overall dry film thickness shall be 1.5 mm subject to minimum 750 gm per sq.m per coat application rate.

Each coat shall be allowed to dry for minimum 12 hours before applying the next coat. The surface should be dry and smooth before application.

The coating shall be continued up the parapets/walls for minimum of 150 mm over the finished roof surface or fillet with suitable tucking into the vertical wall surface. It shall be continued into rain water pipes by atleast 100 mm.

The final coat of PU liquid when tacky shall be sprinkled with the sand.

For edges, expansion joints and any vulnerable points a layer of polyscrim cloth/fabric are to be embedded between 2 finishing coats.

The entire work shall be carried out under the suspension of approved authorized agency.

2.7.3 Surface Finish

Areas of roof treatment shall be provided with wearing course consisting of minimum 25 mm thick PCC 1:11/2:3(using 12.5 mm size aggregate) cast in panel of maximum size of 1.20 m x 1.20 m and reinforced with 0.56 mm diameter galvanized chicken wire mesh and sealing of joints using sealant or elastomeric compound.

When the roof surface is subjected to foot traffic or used as a working area, a cement mortar (1:4) shall be applied over the top most layer of roofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided. The tiles shall be laid as per IS1443.

2.8 WATERPROOFING WITH APP MODIFIED BITUMINOUS MEMBRANE

The RCC roof waterproofing with pre-fabricated APP (atactic polypropylene) modified waterproofing membrane with non woven polyester reinforcement treatment of 4 mm thickness, consisting 160 gsm high Molecular high- density non-woven polyester core, coated on both sides with APP modified bitumen which shall have high penetration, high heat resistance and high softening point. It should also achieve good bonding with substrate and a strong adhesion between overlaps. This polymeric Asphaltic mix shall be protected on the bottom with thermo fusible HMHDPE film, on the top with another layer of HMHDPE. The resultant membrane shall have very good elongation to absorb all structural movements. The cement sand plastered surface on foam concrete is first cleaned to eliminate all sharp projections. Suitable bituminous primer @ 0.27L/SQ.M. (IS:3384) is then coated on the surface. APP modified water proofing roll is unrolled over coated surface is first cleaned (with overlaps of 10cm) and bonded completely to the substrata. The overlaps & complete bottom are then thermo-fused by flame. Special care is taken at singularities such as drains , expansion joints etc.

2.9 SURFACE FINISH

18 mm thick cement sand mortar (1:4) with chicken wire mesh interposed shall be laid over water proofing treatment. Over this, a layer of chequered cement concrete flooring tiles conforming to IS:13801 shall be provided .The tiles shall be laid as per IS :1443.

3.0 ACCEPTANCE CRITERIA

The surface level shall be such as to allow quick draining of rains without leaving any pool anywhere. The finishing course shall be fully secured and shall have an even density. There shall not be any bubble formation or

crushed or squeezed insulation or underbed.

The Contractor shall give a guarantee in writing for all work executed under this specification supplemented by a separate and unilateral guarantee from the specified agency for the roof water-proofing treatment work. The guarantee shall be for materials and workmanship for a period of minimum 10 years. The mode of execution of the guarantee shall be acceptable to the Owner.

4.0 I.S. CODES AND STANDARDS

(a)	IS:73	:	Paving Bitumen
(b)	IS:702	:	Industrial Bitumen
(c)	IS:1203	:	Methods of testing tar and bitumen
(d)	IS:1322	:	Bitumen felts for waterproofing and damp proofing
(e)	IS:1346	:	Code of Practice for waterproofing of roofs with Paving Bitumen
(f)	IS:3384	:	Bitumen primer for use in waterproofing and damp proofing

VOLUME VI/B

SECTION – 20

SANDWICH AND PERMANENT COLOUR COATED METAL CLADDING

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	GENERAL
2.0	PRODUCTS
3.0	DOUBLE SKIN INSULATED METAL CLADDING
4.0	EXECUTION

1.0 GENERAL

1.1 DESCRIPTION

1.1.1 Work included: This section covers the furnishing and installation of sandwich/double skin/single skin metal cladding with insulation for wall/roof as shown in contract drawings including making cut outs for various openings for doors, windows, ducts, pipes etc and fixing of such components with the cladding arrangement with necessary flashing, sealant as required as per contract drawings. The contractor shall furnish all labour, materials, tools and equipment required to complete the work.

1.2 APPLICABLE CODES AND STANDARDS

1.2.1 The following codes and standards are intended to provide an acceptable level of quality for materials and products. The contractor may propose alternative codes and standards provided they give an equivalent degree of quality as the referred codes and standards and are submitted for consultants/owner's approval.

1.2.2 ASTM - American Society for Testing Materials.

(a) A446 Zinc-coated (Galvanized) steel sheets of structural quality Coils and cut lengths

(b) A611 Steel, cold rolled sheet

1.3 SUBMITTALS

1.3.1 The contractor shall submit to the owner the following items for review before commencing work.

(a) Samples

(i) Three 300 x 300 mm pieces of each type of precoated and preformed metal sheet for top skin and bottom skin.

(ii) Three 300 x 300 mm pieces of each type of precoated and preformed metal sheet

(iii) Type of insulation proposed for use and its thickness.

(iv) Fabricated sandwich metal cladding. Sample size shall be 300 x 300 mm three nos.

(v) Edge sealing and flashing.

(b) Manufacturer's literature indicating the nature of preformed profiled, colour coating, manufacturer's recommended installation, instructions and maintenance procedure.

(c) Manufacturer's certification of compliance with each delivery.

(d) Shop Drawings

Showing fabrication details of sandwich/double skin/sigle skin metal cladding with Insulation, preformed sheet profile and total colour thickness for profiled top skin and slightly ribbed bottom skin, thickness and nature of insulation, installation and erection, anchorage, fasteners and details of accessories, metal flashing and its fixing including various openings for doors, windows, louvres, pipes etc.

1.3.2 Test Reports

Two copies of Test Reports and Source of Quality Control Tests.

1.3.3 Supplier Certificates

Two copies of technical data showing that the proposed finish product is suitable for the environmental conditions of the job site and that the materials meet specification requirements.

1.4 PRODUCT HANDLING

1.4.1 Delivery of Materials to job site in manufacturer's original unopened packaging.

1.4.2 Identify contents with name of manufacturer, brand name, thermal value and applicable standard.

1.4.3 Store materials in an area protected from adverse climatic conditions, moisture and open flame or spark and shall be stored off the ground with one end elevated for drainage. The sheets shall be protected from inclement weather with a waterproof covering with ventilation to avoid condensation.

2.0 PRODUCTS

2.1 GENERAL

2.1.1 All goods and products covered by these specifications shall be procured from manufacturer duly approved by the owner.

2.1.2 Cladding material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Single skin materials shall be interlocking type 150mm wide strip.

2.1.3 Material shall be prefabricated panel shall be conformed to relevant ASTM or alternative codes and standard. Troughed galvanized M.S. sheets having 0.6 mm minimum base metal thickness (bare material) with minimum rate of galvanization of 275 gms./sq.m. as per IS-277 of minimum yield strength of 250MPa as per IS-513(or High tensile steel sheet coated with zinc aluminium alloy @ 150 gms./sq.m. of 0.5 mm minimum base metal thickness and having minimum yield strength of 350 MPa, as per AS-1397) shall be used for the cladding system.

2.1.4 The outer side (exposed face) shall be permanently colour coated with Silicon modified polyester paint of minimum DFT 20 microns over primer, of approved colour/shade and the inner side (internal face) shall be coated with same paint of minimum DFT 20 microns over primer of off-white shade

2.1.5 Roof insulation shall have a minimum R-value of 2.083 M2 ^{o}K/Watt. Thickness of sandwich cladding shall be as required to meet the specified "R" values.

2.1.6 Sandwich material shall be of "Rib and Flute" design to ensure wide spanning and quick recovery after being subjected to excessive load. Double skin materials shall be interlocking type 150mm wide strip and inner sheet shall be mild rib & flute type profile to ensure quick recovery after being subjected to excessive load.

2.1.7 Material

(a)	Base Material	:	High tensile steel
(b)	Metal protection	:	Galvalume
(c)	Organic coating	:	SiliconModified Polyester (SMP) Fluoro polymer (PVF2) and plastisols to resist aggressive climate of the jobsite.

2.1.8 Material shall be prefabricated sandwich panel with polystyrene insulation /high density rock wool slab insulation shall be conformed to relevant ASTM or alternative codes and standard. Insulation shall be bonded to steel sheet with industrial grade adhesive. Sheeting material shall be preformed and precoated profile sheeting of thickness 0.60 mm or as recommended by manufacturer to resist the climate of the jobsite for Top skin (Weather side) and Bottom skin or inner side slightly ribbed type and minimum 0.5 mm thick or as recommended by manufacturer of similar pre coated panel

2.1.9 Insulating core shall vary from 25 mm to 100 mm thick according to the climatic requirement of the site and shall be either polystyrene block or rock wool slab made to profile of the sheet. The maximum density shall be 32.35 Kg/ M^3 for polystyrene and shall have minimum R-value 2.083 M^2 ^{o}K/Watt.

2.1.10 Panel size shall be largest available size.

2.1.11 Warranty for precoated profiled metal sandwich /double skin cladding shall be for a minimum period of 40 years.

2.1.12 Sealants

Penetration and end laps in sheeting shall be sealed with a non-hardening approved sealant as recommended by the manufacturer.

2.1.13 Profile HDPE Filler

(a) Profile HDPE Filler shall be die cut in profile to match the profile of the sheet.

(b) Metal flashing shall be of similar material and colour of top skin.

3.0 DOUBLE SKIN INSULATED METAL CLADDING

3.1 GENERAL

3.1.1 Metal cladding may be of double skin separated by an approved insulation in between. External sheet shall be of interlocking type.

3.1.2 Double skin wall cladding shall be comprising of 150F external panels manufactured out of 0.6 mm TCT (Total coated thickness) aluminium alloy AA3105/5050 with stove enamelled coil coated finish, sufficient to withstand most aggressive climate, on both sides of approved shade. The 150mm wide panels (150F) shall be clipped on to the concealed runners and shall be interlocked with each other. The inner sheeting shall be Hi Rib 0.5mm TCT silicon modified polyester coated galvalume steel (AZ 150 gsm aluminium- Zinc alloy meta metallic coating of total 550 Mpa yield stress as per AS-1397). The external panels shall be 150mm wide 17mm deep. The inner sheet shall have 1000-1020 mm cover width 28-30 mm high crests @250-255mm c/c with side laps. The inner sheet shall be fixed to structural system by means of corrosion protected self-drilling, self-tapping fasteners. The sub girts of size 50mmx50mmx50mm manufactured out of 16 G G.I (1.6mm) 'Z' shape shall be fixed to inner sheeting on face side at purline

locations. The external panels shall be fixed with the help of concealed runners 34.5 wide x48mm deep out of 0.95 mm thick aluminium strip with cut outs to hold the panels in a module of 150mm at 1600mm c/c and fastened on side girts. The runners shall be concealed and no fasteners are to penetrate the panels. An insulation of 50mm thick resin bonded fiberglass roll insulation of density 16kg/m3 shall be fixed in the cavity between two sheets. Contractor shall make cut out of doors, windows, louvres, pipe, ducts or other cut outs as required as per contract drawings along with flashing, leak proof sealing etc as required for these cut outs/wall openings.

4.0 EXECUTION

4.1 INSPECTION

4.1.1 The contractor shall examine the area, which will be covered, and the masonry wall where the edge of the sandwich/double skin/single skin cladding will be fixed and the structural alignments.

4.1.2 Contractor shall correct any unsatisfactory conditions prior to start of work.

4.2 INSTALLATION

4.2.1 Sandwich / metal permanently coated panel shall be fixed over structural members with joints overlapped and fastened using stainless steel fasteners self-drilling type or as recommended by the manufacturer.

4.2.2 Double skin /single skin wall cladding shall be installed strictly as per manufacturer specification and details.

4.2.3 All end laps of profiled sheeting and joints of flashing shall be sealed properly with non-hardening natural cure silicon sealant or as recommended by the manufacturer.

4.2.4 Accessories like fasteners, tape, and foam fillers, flashing etc. as required shall be provided as per recommendation of manufacturer.

4.2.5 The external panels shall be fixed with the help of concealed runners aluminium strip with cut outs to hold the panels and fastened on side girts. The runners shall be concealed and no fasteners are to penetrate the panels.

4.2.6 Contractor shall make cut out of doors, windows, louvres, pipe, ducts or other cut outs as required as per contract drawings along with flashing, leak proof sealing etc as required for these cut outs/wall openings.

4.3 CLEAN-UP

Remove sealant splatters and smears remove steel particles generated by drilling to avoid damage.

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SECTION-21

WATER SUPPLY

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	TESTING AND ACCEPTANCE
4.0	I.S. CODES

1.0 SCOPE

This section includes supply of all materials, labour and incidentals for water supply for residential, business and industrial and other types of buildings. The water supply system of a building or premises covers service pipes and the necessary connecting pipes, fittings, control valves and all appurtenances in or adjacent to the building or premises.

1.1 MATERIALS

All materials, fittings, fixtures and appliances shall be of the best quality conforming to relevant Indian Standard and shall be procured from approved manufacturers. Unless specifically allowed by the Engineer, the Contractor shall submit samples of fittings and fixtures which will be retained by him for comparison when bulk supplies are received at the site. Ultimate choice of type, model and manufacturer lies completely with the Engineer.

It shall be the responsibility of the Contractor to procure the materials selected by the Engineer. Hence order is to be placed with the manufacturers in time, so that the materials are available at the site well ahead of their requirement.

The materials brought to the site, shall be stored in a separate secured enclosure away from the building materials. Pipe threads, sockets and similar items shall be specially protected till final installation. Brass and other expensive items shall be kept under lock and key. Fragile items shall be checked thoroughly when received at the site and items found damaged shall not be retained at the site.

1.2 PIPES AND PIPE FITTINGS

Under scope of this specification, pipes and pipe fittings may be any or a combination of the following types :

(a) Cast Iron

(b) Steel: lined, coated with bituminous composition, out coated with

cement concrete or mortar or galvanised.

(c) Reinforced Concrete

(d) Priestesses Concrete

(e) Lead (Not to be used for potable water)

(f) P. V. C.

(g) Copper

(h) Brass

(i) Wrought iron

1.3 WATER RESERVOIRS

Water reservoirs like pressed steel tanks and G.I. tanks shall come under scope of this specification. Reservoirs made of concrete masonry or fabricated steel shall be covered by respective work specifications.

1.4 RELATED WORKS

All works, like earthwork, masonry, concrete, steelwork, cutting holes, chases, repairs and rectification associated directly with installation of water supply systems shall come under scope of the Contractor unless specifically excluded.

1.5 REGULATION

The work which is required to be carried out under the scope of this section, shall be executed by a licensed plumber only (engaged by the Contractor) and he shall obtain all necessary sanctions, permissions, certificates etc. from Municipal and/or other Local Authorities and shall abide by all the rules of such Authorities.

2.0 INSTALLATION

While basic layouts may be available in the drawings provided by the Owner, the details might have to be supplemented by the Contractor for approval of the Engineer.

Special attention shall be given by the Contractor to economy. Symmetry of layout is very important. Fittings meant for operation shall be located and oriented to allow easy reach and operation. Maintenance, repairs and replacements of pipes, fittings and fixtures must be conveniently possible.

2.1 PIPE LINES

2.1.1 Laying

In addition to fulfilling the functional requirements all pipelines shall be laid true to line, plumb and level. Any deviation shall need approval of the Engineer. Meticulous care shall be taken to avoid chances of airlock and water hammer.

Pipes shall be laid on continuous unyielding surface or on reliable supports at least one near each joint and spacing as directed by the Engineer. The support must be strong, neat and shall have provisions for securing the pipes in every direction and easy maintenance. Pipes shall be encased or concealed in masonry or concrete if shown on drawing or directed by the Engineer.

2.1.2 Back Flow

The layout of pipe work shall be such that there is no possibility of back flow towards the source of supply from any cistern or appliances, whether by siphonage or otherwise. All pipe works shall be so laid or fixed and maintained as to be and to remain completely water-tight, thereby avoiding waste of water, damage of property and the risk of contamination of the water conveyed.

2.1.3 Contamination

There shall be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose.

No piping shall be laid or fixed so as to pass into or through any sewer, scour outlet or drain or any manhole connected therewith.

2.1.4 Underground Pipings

Underground piping shall be laid at such a depth that it is not likely to be damaged by traffic and other loads and frost, where applicable.

The size and depth of the trench shall be as approved by the Engineer. Back-filling shall be done with selected fine earth, unless otherwise permitted in 150 mm layers and carefully consolidated. Special care shall be taken while filling in the vicinity of the pipe to avoid damage. Before backfilling the laid pipe shall be fully tested and approved.

Where the pipe rests on rock it may be bedded on a layer of fine selected material or concrete to avoid local point support.

The trench shall be so treated by gradient and filling in the area that it does not act as a drainage channel.

2.1.5 Concealed Piping

Where desired by the Engineer or shown on the drawings the pipes shall be concealed in masonry or concrete of the structure. The Contractor may co-ordinate with the building Contractor for leaving the chases, openings, conduits as necessary. However, the Contractor will rectify if required the chases, openings and conduits, supplement and make good after laying and testing of the concealed pipelines.

2.1.6 Jointing of Pipes

Jointing of pipes shall be completely leakproof and durable. Instruction of them manufacturer shall be followed unless desired otherwise by the Engineer. However, usually recommended practices are stated below for guidance:

(a) Cast Iron

(i) Spigot and Socket Joints

Lead joint : The joint is made by first caulking in clean spun yarn upto half depth and filling the reminder by running in molten lead taking care that no dross enters the joint and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket. After completing the joint it shall not be allowed to move. For rectification the joint shall be completely redone.

(ii) Flanged Joints : Flanged joints shall be made by jointing rings of good quality, smooth and hard compressed fibre board of thickness not less than 1.5 mm and of such width as to fit inside the circle of bolt. Diagonally opposite bolts shall be tightened in pairs and in stages so that degree of all bolts in a joint are similar. Damaged gaskets shall be replaced.

(b) Steel

Plain ended steel pipes may be jointed by welding. Screwed and socketed joints shall be carefully tightened. Care shall be taken to remove any burr from the ends of the pipes. Jointing compound, if used, shall be lead free and approved by the Engineer. Once a joint has been screwed up it shall not be backed off unless threads are reclined and new compound applied.

(c) GI Pipes

Threads shall be cut with sharp tools, and before jointing all scales shall be removed from pipes by suitable means. The screw / threads of the pipe shall be cleaned out and the joint made by screwing the fittings after treating the threads with approved pipe jointing compound. Once a joint has been screwed up it shall not be backed off unless threads are recleaned and new compound applied.

(d) Lead

Lead and lead alloy pipes shall be jointed with wiped solder joints.

(e) Concrete

Concrete pipes may be socket and spigot ended collar or band jointed. Joints shall be effected by caulking with 1:3 cement sand mortar.

(f) P. V. C.

Manufacturer's instruction shall be followed. For heating approved equipment with adequate control shall be used.

(g) Tyton Joint

The manufacturer's instruction shall be strictly followed in making such joints. Tyton joints shall be made by push-on type specification stipulated by the pipe manufacturer. The tools specified by the pipe manufacturer shall be used to secure the joint fully.

2.1.7 Painting

Where mentioned in the Schedule, underground steel and cast iron pipes shall be given 2 coats of bituminous paint on the outside after laying, when painting is to be done above ground G.I. pipes shall be given a coat of zinc chromate primer, C.I. and M.S. pipes shall be given one coat of red lead

or zinc chromate primer. Top coats shall be minimum 2 coats of best quality paint.

2.2 STORAGE TANK - PRESSED STEEL TANK

Unless otherwise mentioned, water storage tanks shall be pressed steel tanks of nominal size and capacity as mentioned in the Schedule and fabricated with all flanges external, all flanges internal, or bottom flange internal and side flanges external, as shown on drawings or schedule of items. The fabricator shall supply 6 prints of fabrication drawings to the Engineer for prior approval showing thickness of plates, method of jointing the plates, all supports, stays, gussets etc. Pads, cleats etc. required for supporting the tanks shall be supplied by the manufacturer. Inlet, overflow vent pipes, manholes etc. shall be arranged and provided as shown on \ drawing or mentioned in the schedule. Unless otherwise specified, the outlet pipe shall be 50 mm above the bottom of the tank and there shall be a 150 mm free board at the top of the tank.

All tanks shall be supplied with mosquito-proof covered top with manhole not less than 450 mm diameter. Tanks deeper than 1.00 Metre shall be provided with m.s. Internal access ladder adjacent to the manhole. Water level indicator shall be provided if asked for. Two coats of anti-corrosive paint over a suitable primer shall be applied to both internal and external surface of tanks. Such paint if used shall not impart any taste or odour to water and be of lead free composition.

Erection of tanks shall be in accordance with detailed drawings and manufacturer's instructions. The two finishing coats of paint shall be applied to outside after erecting is complete.

2.2.1 G. I. Water Tank

G. I. water tanks shall be procured from a reputed manufacturer. The design shall be good enough to withstand the loads safely. Galvanised iron water storage tank shall be made of minimum 2 mm thick galvanised iron sheet. Plain sheets shall be fixed at the corner to angle iron frames by means 6 mm rivets at 40 mm pitch for tanks upto 1000 litres capacity and 8 mm rivets at 35 mm pitch for tanks above 1000 litres capacity. Tanks above 1000 litres shall have 20 mm dia. galvanised / iron stay rods, one fixed to

angle framing at top and two in the body of the tank for extra strength. Holes for riveting shall be drilled and not punched. White lead shall be applied to the joints before riveting.

In case it is desired by the Engineer that corners of tank should be welded instead of riveted then the sheets shall be welded to form a tank will not have angle iron frame.

Tanks shall have 400 mm dia. holes at the top with hinged covers. The covers shall be made of galvanised iron sheet with angle iron frame. The cover shall be just loose but close fitting to keep out dust and mosquito and will not be airtight. It shall be complete with lockable arrangement.

Tanks shall be provided with rising main inlets of 40 mm dia. galvanised iron pipe or as shown on Drawing and 25 mm dia. G.I. overflow pipe. The rising main shall be connected to the tank with a ball valve near the top which disconnects the supply when tank is full up to the point of overflowing.

The ball valve permits the entry of water when the tank is empty and disconnects the supply when the tank is full. It consists of a hollow floating ball made of copper, plastic or hand Tubers, 110 mm in diameter, attached to an arm which is so pivoted that the end near the pivot closes the orifice of the main when the ball is raised to the required height of water in the tank and opens the main as soon as the ball drops with the fall of water level as it is drawn off through the distribution pipes. The ball valve shall be fixed to the tank independent of the inlet pipe and set in such a position that the body of the ball valve cannot submerge when the tank is full upto the water line. The ball valve shall be so adjusted as to limit the level of the water line. The level of the water in the tank to 75 mm below the lip of the overflow pipe. Free surface shall be about 150 mm above the maximum water filled level.

2.3 VALVE, COCKS, TAPS

All valves, stop cocks, taps etc. shall conform to relevant Indian Standard Specification and shall be of best quality from approved manufacturers.

These shall be suitable for working pressures mentioned in the Schedule. Nominal size and material shall be as per schedule.

2.4 PROTECTION

Open end of each pipe shall be protected during installation by suitable covers or plugs so that the ends, threads, sockets or spigot are not damaged and no foreign material can find its way into the pipe line.

Fittings and fixtures liable to be misused or stolen during the construction phase shall be fitted only before testing and handing over.

3.0 TESTING AND ACCEPTANCE

3.1 INSPECTION BEFORE INSTALLATION

All pipes, fittings and appliance shall be inspected, before delivery at the site to see whether they conform to accepted standards. The pipes and fittings shall be inspected on site before laying and shall be sounded to disclose cracks. Any defective items shall be clearly marked as rejected and forthwith removed from the site.

3.2 TESTING OF 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 a 25 mm 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 5 Kg/CM2 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 unattached. 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 less for at least five minutes. The end of the main shall be closed by fitting a water-tight expanding plug and the plug shall be secured by struts to resist the end thrust of the water pressure in the mains.

3.3 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. The service pipe shall then be inspected under working conditions of pressure and flow. When all draw- off taps are closed, the service pipes shall be absolutely water-tight. All piping, fittings and appliances shall be checked for satisfactory support and protection from damage, corrosion and frost.

4.0 I.S. CODES

Important relevant IS Codes for this Specification are listed below : Latest editions shall always be consulted.

(a)	IS:2065	:	Code for Practice for water supply in buildings
(b)	IS:1172	:	Code of basic requirements for water supply, drainage & sanitation
(c)	IS:1200 (Pt. XVI)	:	Lying of water and sewer lines including appurtenant items.
(d)	IS:1239 (Pt. I & II)	:	Specification for Mild Steel Tubes and Mild Steel Tubulars and other wrought steel pipe fittings (10 mm to 15 mm nominal diameter)
(e)	IS:1536	:	Specification for Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
(f)	IS:1537	:	Specification for vertically cast iron pressure pipes for water, gas and sewage.
(g)	IS:3486	:	Specification for Cast iron spigot and socket drain pipes (80 mm to 250 nominal diameter)
(h)	IS:3589	:	Specification for Electrically welded steel pipe for water, gas and sewage (200 mm to 2000 mm nominal diameter)
(i)	IS:784	:	Prestressed concrete pipes

(j)	IS:458	:	Concrete pipes (with or without reinforcement)
(k)	IS:783	:	Code of Practice for laying of concrete pipes
(l)	IS:1592	:	Asbestos cement pressure pipes
(m)	IS:1626	:	Asbestos cement pressure pipes, gutters and fittings (Spigot and Socket types)
(n)	IS:404	:	Lead pipes
(o)	IS:3076	:	Low density polyethylene pipes for potable water supplies
(p)	IS:4984	:	High density polyethylene pipes for potable water supplies
(q)	IS:2501	:	Copper tubes for general engineering purposes
(r)	IS:407	:	Brass tubes for general purposes
(s)	IS:1230	:	Cast iron rain water pipes and fittings
(t)	IS:804	:	Rectangular pressed steel tanks

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SECTION - 22

DRAINAGE AND SANITATION

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	INSTALLATION
3.0	TESTING AND ACCEPTANCE
4.0	CODES AND STANDARDS
ANNEXURE –I	SEWAGE TREATMENT PLANT

1.0 SCOPE

1.1 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.

2.0 INSTALLATION

2.1 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 leak proof. When the works under scope of this specification linked up with works executed by others, the connections shall be such as to prevent any splashing or spilling or emission of foul odour and gases.

2.2 RAINWATER DOWNCOMERS

Rainwater down comers shall be standard Cast Iron Pipes. In case where specifically desired, M.S. pipes may also be used. M.S. pipes shall be painted outside with two coats of anticorrosive paints under a coat of primer.

Rainwater downcomers shall run along and be secured to walls, columns etc. where desired by the Engineer these may have to be installed in chases cut in the structure

All pipes shall be well secured and supported by adequately strong brackets.

The brackets may be wrought iron clevis type, split ring type or perforated strap iron type as approved by the Engineer. For vertical runs each pipe shall hang freely on its brackets fixed just below the socket. Suitable spacer blocks shall be provided against the vertical surface to which the pipe is fixed.

All bends and junctions shall be supplied with watertight cleanouts.

Roof and floor drains and yard gullies shall be installed, if required, by cutting into the structure and grouted with 1:2:4 cement concrete. All gutters shall be provided with removable gratings.

All horizontal pipes shall have a minimum fall of 1 in 100.

2.3 GUTTERS

The gutters shall be made of G.I. All gutters shall be supplied by reputable specialised firms. Each section shall be sufficiently rigid, edges and corners straight and the slopes perfectly uniform. G.I. 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 M.S. brackets. All junctions shall be thoroughly watertight. The joints may be made by rivetting, bolting or soldering. All joints between successive lengths of gutters shall have on overlap of at least 5 cm. 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.

2.4 SOIL AND DRAINAGE PIPES

2.4.1 Gradients

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

(a) 100 mm nominal dia : 1 in 35

(b) 150 mm nominal dia : 1 in 65

(c) 230 mm nominal dia : 1 in 120

(d) 300 mm nominal dia 1 in 200

2.4.2 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.

2.4.3 Laying

Each separate pipe shall be individually set for line and for level. Where lengths of sewer or drain pipes are laid in trench, properly painted sight rails shall be fixed across the trench at a height, equal to length of the boning rod to be used, above the required invert level of the drain or sewer at the point where the sight is fixed. More sight rails shall be required at manholes, change of gradient and intermediate positions if the distance for sighting is more than 50 ft. apart. The excavation shall be boned in at least once in every 6 ft. The foot of the boning rod shall be set on a block of wood of the exact, thickness of the wall of the pipe. Each pipe shall be separately and accurately boned between sight rails.

2.4.4 Support and Protection on 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:

(a) When cover is less than 2 metre below ground level and where pipes are unavoidably exposed above ground surface, the pipes shall be completely encased or surrounded with concrete.

(b) Where pipes are laid on soft soil with the maximum water table laying at the invert of the pipe, the sewer shall be bedded on concrete.

(c) 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.

(d) 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.

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 besecured to the supports by approved means.

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

2.4.5 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.

2.4.6 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.

2.4.7 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 50 mm 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 C.I. unless desired otherwise by the Engineer.

2.4.8 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 gull chamber shall not exceed 6 metre 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 splashings 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.

2.4.9 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.

2.4.10 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. with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

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 instructions 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.

(a) Cast Iron Pipes

Socket and spigot pipes shall be jointed by the cast lead joints. The spigot shall be centered 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 3 mm behind the socket face.

Joints in cast iron pipes with special jointing arrangements like 'Tyton'joints etc. shall follow the instructions of the manufactures.

In special cases if flanged joints are accepted by the Engineer the joints shall be made leak proof by inserting approved type of rubber gaskets. The bolts shall be secured in stages to avoid uneven strain.

(b) Concrete Pipes

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

2.5 TRENCHES AND OTHER EXCAVATIONS

Width of the trench at the bottom shall be such as to provide 200 mm 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 behind the work.

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. 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 300 mm over the pipe shall also be filled with soft earth or sand. Consolidation shall be done in 150 mm 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.

2.6 FIXTURES

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

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.

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

Unless specified in the contract the fixtures shall be as specified hereinafter

2.6.1 Water closet

(a) Raised type

It shall include glazed vitreous china basin with siphon, open front solid plastic seat and plastic cover, low level glazed stoneware flushing cistern with valveless fittings, supply connections and

necessary fittings. All fittings shall be chromium plated. Colour of basin, cistern, seat and cover shall be as desired by the Engineer.

(b) Squatting type

It shall include glazed vitreous china pan with foot rests and high level cast iron flushing cistern with valve less fittings, supply connections and necessary fittings. All fittings shall be chromium plated. The foot rests shall be made of white glazed vitreous china with chequered surface. The flushing cistern shall be painted as desired by the Engineer.

2.6.2 Urinals

It shall consist of wall type glazed vitreous china urinals, cast iron automatic flushing cistern complete with supply connections, flush pipe, lead pipes, gratings, traps and all other necessary fittings. Automatic flushing shall be approximately once every five minutes. For a number of urinals located together may be served by one cistern of adequate capacity. All fittings shall be chrome plated.

2.6.3 Wash basin

It shall be made of glazed vitreous china. The basin shall be flat back, wall hung by painted cast iron brackets and complete with pattern with hot and cold brass faucets with nylon washers, waste chain, waste washers, lead waste pipes with traps, perforated waste complete with necessary fittings. All fittings including faucets shall be chromium plated.

2.6.4 Sink

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

2.6.5 Bathroom mirror

It shall be made of the best quality 6 mm thick glass 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.

2.6.6 Glass shelves

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

2.6.7 Towel rail

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

2.6.8 Soap holder

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

2.6.9 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.

2.6.10 Toilet roll holder

It shall be made of glazed vitreous china with suitable cover cum cutter. Wall mounting screws shall be chromium plated.

2.6.11 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.

2.7 EFFLUENT DISPOSAL

2.7.1 Effluent Disposal

The effluent from the septic tank shall be disposed by allowing it into an open channel or a body of water if the concerned authority approves or into a soak pit for absorption by soil or shall be allowed to be absorbed by soil through open jointed CI pipes laid in a trench filled with broken bricks.

2.7.2 Joining C.I. Pipes / dispersion trenches Minimum dia of the CI pipe shall be 150 mm nominal. The trench for laying the pipes shall be minimum 600 x 600 mm pipes. The joints of the pipes shall be made with lead. The entire length of the pipe within the trench shall be buried in 250 mm layer gravel or crushed stone of uniform size. On top of gravel/crushed stone layer is a 150 mm bed of well graded coarse aggregate. Ordinary soil is used for fill in the top of trench.

2.8 SEWAGE TREATMENT PLANT

Please refer. Annexure-I

3.0 TESTING AND ACCEPTANCE

3.1 INSPECTION BEFORE INSTALLATION

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.

3.2 TESTING OF PIPELINES

Comprehensive tests of all pipe lines shall be made by simulating conditions of use. The method of actual tests shall be decided by the Engineer. All test data 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 tests are given below:

(a) Smoke test

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

(b) Water test

For pipes other than Cast Iron

Glazed ware and concrete pipes shall be subjected to a test pressure of at least 1.5m head of water at the highest point of the section under tests. The tolerance figure of two litres per centimetre of diameter per kilometre may be allowed during a period of 10 (ten) minutes The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of the vertical pipe jointed to it so as to provide the require test head or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation.

Subsidence of test water may due to one or more of the following cases :

(i) Absorption by pipes and joints

(ii) Sweating of pipes or joints

(iii) Leakage at joints or from defective pipes

(iv) Trapped air.

Allowance shall be made for (a) by adding water until absorption has ceased and after which the test proper should commence. Any leakage and the defective part of the work shall be cut out and made good.

For cast iron pipes

Cast iron sewers and drains shall be tested as for glazed ware and concrete pipes. The drain plug shall be suitably strutted to prevent their being forced out of the pipe during the test.

(c) For straightness

(i) By inserting at the high end of the sewer or drain a smooth ball of a diameter 13 mm less than the pipe bore. In the absence of obstruction, such as yarn or mortar projecting through the joints, the ball with roll down the invert of the pipe end emerge at the lower end; and

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

3.3 FIXTURES ETC.

All fixtures and fittings shall be connected by watertight joints. No dripping shall be accepted.

4.0 CODES AND STANDARDS

Some of the important Codes and Standards relevant to this specification shall be followed: Latest editions shall always be consulted.

(a)	IS:1172	:	Code of basic requirements for water supply drainage and sanitation
(b)	IS:1200	:	Lying of water and sewer lines including appurtenant items. (Pt. XVI)
(c)	IS:1239	:	Mild Steel Tubes and Mild Steel Tubular and other (Pt. I & II) wrought steel pipe fittings
(d)	IS:1536	:	Centrifugally cast (Spun) iron pressure pipes for water gas and sewage
(e)	IS:1537	:	Vertically cast iron pressure pipe for water, gas & sewage. -
(f)	IS:3486	:	Cast Iron spigot & socket drain pipes
(g)	IS:1537	:	Vertically cast iron pressure pipe for water, gas & sewage
(h)	IS:3486	:	Cast Iron spigot & socket drain pipes
(i)	IS:1742	:	Code of Practice for building drainage
(j)	IS:5329	:	Code of Practice for sanitary pipe work above ground for buildings
(k)	IS:2470	:	Code of Practice for designs and construction of septic tank for small and large installations
(l)	IS:3076	:	Low density polythelene pipes for potable water supplies.
(m)	IS:4984	:	High density polythelene pipes for potable water supplies.

(n)	IS:1537	:	Vertically cast iron pressure pipes for water, gas and sewage.
(o)	IS:1538	:	Cast Iron fittings for pressure pipes for water, gas & sewage.
(p)	IS:1230	:	Cast Iron rain water pipes and fittings.
(q)	IS:3889	:	Centrifugally cast (spun) iron spigot & socket soil waste and ventilating pipes, fittings and accessories.
(r)	IS:1729	:	Sand cast iron spigot & socket soil, water and ventilating pipes and accessories.
(s)	IS : 1626	:	Asbestos cement building pipes, gutters and fittings (spigot & socket types)
(t)	IS:458	:	Concrete pipes (with and without reinforcement)
(u)	IS:783	:	Code of Practice for laying of concrete pipes.
(v)	IS:784	:	Prestressed concrete pipes.
(w)	IS:651	:	Salt glazed stoneware pipes & fittings
(x)	IS:4127	:	Code of practice for laying of glazed stoneware pipes
(y)	IS:1726	:	Cast Iron manhole covers and frames intended for use in drainage works
(z)	IS:5961	:	Cast Iron gratings for drainage purposes
(aa)	IS:5219 (part- I)	:	'P' & 'S' traps.
(bb)	IS:771	:	Glazed earthen-ware sanitary appliance.

(cc)	IS:772	:	General requirements of enamelled cast iron sanitary appliances.
(dd)	IS:774	:	Flushing cistern for water closets & urinals (valveless siphonic type)
(ee)	IS:775	:	Cast Iron brackets & supports for wash basins and sinks
(ff)	IS:2548	:	Plastic water closet seats & covers.
(gg)	IS:2527	:	Code of Practice for fixing rain water gutters and down-pipes for roof drainage.

ANNEXURE –I

SEWAGE TREATMENT PLANT

DESIGN BASIS

The raw sewage quantity shall be estimated based on total no. of users. The anticipated no. of users may be considered as 1500 for design purpose. The proposed raw sewage and treated water characteristics are as follows:

(a)	Parameter	Unit	Inlet	Outlet
(b)	Total Suspended Solids (TSS)	mg/l	200	<10
(c)	BOD	mg/l	300	<10
(d)	COD	g/l	-	-
(e)	Oil & Grease	mg/l it	20	-

1.0 TREATMENT FACILITIES

1.1 The treatment facilities comprise the following process units:

1.1.1 Pre Treatment

1.1.2 Inlet Chamber and Screen Chambers

1.1.3 Raw sewage transfer pumping station

1.1.4 Grit Chamber & Fine screen chamber

1.1.5 Aeration Basin

1.1.6 Membrane Bio reactor

1.1.7 Dis infection

1.1.8 Treated water Reservoir

1.1.9 Sludge Sump

2.0 PROCESS DESCRIPTION

2.1 INLET CHAMBER

An Inlet chamber is provided to receive the raw Sewage from various building.

2.2 MEDIUM SCREEN

Raw Sewage passes through medium bar screen with 20 mm opening wherein floating material of size greater than 20 mm will get trapped. The cleaning of the screens would be done manually.

2.3 RAW SEWAGE SUMP CUM EQUALISATION

Raw sewage is collected in the sanitary water storage tank where besides arresting the turbulence, flow equalisation also takes place. The storage tank is designed for 1 day storage. Submersible pumps shall transfer the sewage from this sump to the grit chamber for further treatment.

2.4 GRIT CHAMBER

The flow from the sanitary water storage tank shall be passed into the 2(1W+1S) grit chamber tanks for removal of grit/inorganic matter. It is a channel in which sewage flows continuously where grit/inorganic matter get settled down according to settling velocity of grit particles. The settled grit particles get disposed off through chute. Grit free sewage flows to Fine bar screen chamber.

2.5 FINE BAR SCREEN CHAMBER

The grit free sewage is subjected to screening in the mechanical fine bar screens of 2mm opening. The fine material will be screened and lifted by the rake, taken out through belt conveyor and dropped on to the trolley.

2.6 AERATION BASIN

The sewage from the fine bar screen is transferred into the aeration basin, where Air is supplied to provide oxygen for BOD removal and for nitrification process.

2.7 MBR BASIN

Partially stabilized mixed liquor from aeration tank will flow into the MBR basin by gravity. Membranes are placed in the tank. Diffusers supply air for membrane cleaning and mixing requirements. Part of the mixed liquor is recycled back to the aeration basin. The excess sludge from aeration basin shall be sent to sludge holding tank. The sludge from Sludge holding tank will be disposed to ash pond by means of sludge transfer pumps.

2.8 DISINFECTION

The treated sewage from MBR shall be chlorinated with sodium hypo chloride and the chlorinated water will be stored in treated sewage storage tank.

SEWAGE TREATMENT PLANT

LIST OF CIVIL UNITS

(a) Inlet Chamber

(b) Manual Screen Chamber

(c) Sanitary Water Storage tank

(d) Grit Chamber

(e) Fine screen chamber

(f) Aaeration tank

(g) MBR Tank

(h) Sludge Holding Tank

(i) Chemical House

SEWAGE TREATMENT PLANT

LIST OF MECHANICAL EQUIPMENT

		TOTAL	WORKING	STANDBY	MATERIAL OF CONSTRUCTION
(a)	Manual Bar Screen	2	1	1	SS316
(b)	Sanitary Water transfer pumps	2	1	1	C :CI ,I: FRP;Shaft:SS316
(c)	Submercible Mixer	1	1	0	SS304
(d)	Grit Chamber	2	1	1	RCC
(e)	Fine bar screen Recirculation	2	1	1	SS316
(f)	Recirculation pumps	2	1	1	C :CI ,I: FRP;Shaft:SS316
(g)	Diffuser - Preaeration Basin	1	lot		EPDM/Silicone
(h)	Submerged Membrane Units	-	-	-	-
(i)	Aeration Air blower	2	1	1	CI
(j)	MBR air blower	2	1	1	CI
(k)	Permeate Pumps	1	1	0	C & I;CI
(l)	CIP cleaning Tank	1	1	0	HDPE
(m)	CIP cleaning Tank agitator	2	1	1	SS316
(n)	CIP cleaning chemical feed pump	1	1	0	PP
(o)	Hypo Dosing Tank	2	1	1	FRP

(p)	Hypo Dosing Pumps	1	1	0	Diaphragm :PTFE
(q)	Hoist	2	1	1	MS

VOLUME VIII/B

SECTION – 23

ANTI-TERMITE TREATMENT

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	EXECUTION
3.0	ACCEPTANCE CRITERIA
4.0	METHOD OF MEASUREMENT
5.0	I.S.CODES

1.0 SCOPE

The scope of work is to set up a chemical barrier against attack by subterranean termites while the building is under construction.

2.0 EXECUTION

2.1 GENERAL

All work shall in general be executed as specified in IS: 6313 Part II-1981 and as per approved specification of the agency having special know-how for the job.

All necessary work to ensure uniform distribution and proper penetration of treatment of treating solution shall be done according to the instruction of the Engineer.

Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

2.2 CHEMICALS AND RATE OF APPLICATION

Any of the following chemicals (conforming to relevant Indian Standards) in water emulsion shall be applied by pressure pumps, uniformly over the area treated.

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(a) Chlorpyrifos Emulsifiable (IS 8944 - 1978) : 1.0

(b) Heptachlor Emulsifiable Concentrate (IS: 6439 - 1978) Chlordane Emulsifiable : 0.5

(c) Concentrate (IS: 2682 - 1984) : 1.0

2.2.1 Treatment of Column Pits, Wall Trenches and Basement Excavations

Foundations, basements etc. may either be fully enveloped by the chemical

barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation (upto a height of about 300 mm) for column pits, walls trenches and basements shall be treated with chemicals at the rate of 5 litres / M2 of surface area. Backfills around columns, walls etc. shall be treated at the rate of 7.5 litres / Sqm of the vertical surface. Chemical treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the chemicals in the specified dose.

2.2.2 Treatment of Top Surface of Plinth Filling

Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crowbars on the surface of compacted plinth fill. Chemical emulsion at the rate of 5 litres / M2 of surface shall be applied prior to laying soling or sub- grade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

2.2.3 Treatment of Soil Surrounding Pipes, Wastes and Conduits

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building.

2.2.4 Treatment of Expansion Joints

These shall receive special attention and shall be treated in a manner approved by the Engineer.

2.2.5 Treatment at Junction of the Wall and the Floor

Special care shall be taken to establish continuity of the vertical chemical
barrier on inner wall surfaces from ground level up to the level of the filled earth surface.

A small channel 30 x 30 mm shall be made at all the junctions of wall and columns with the floor. Rod holes made in the channel up to the ground level 150 mm apart and the chemical emulsion poured along the

channel at the rate of 7.5 litres per square meter of the vertical wall or column surface. The soil should be tamped back into place after this operation.

3.0 ACCEPTANCE CRITERIA

The Contractor shall give a 10-year service guarantee in writing supplemented by a separate and unilateral guarantee from the specialised agency for the job to keep the building free of termites for the specified period.

4.0 METHOD OF MEASUREMENT

Complete work of anti-termite treatment shall be measured for plinth area treated.

This includes treatment, to foundations, walls, trenches, basements, plinth, burried pipes, conduits etc. The extended portions of foundation and like beyond plinth limit shall be the part of complete work.

5.0 I.S. CODE

Relevant code applicable for this Specification.

(a) IS: 6313 (Part-II) : 1981 — Code of Practice of Anti-Termite Measures in Buildings Pre-constructional chemical treatment measures.

VOLUME VI-B

SECTION – 24

SHEETING WORK IN ROOF AND SIDING

CONSULTANT : PROCON ENGINEERS

CONTENTS

CLAUSE. NO.	DESCRIPTION
1.0	SCOPE
2.0	STORAGE,HANDLING & INSTALLATION
3.0	ACCEPTANCE CRITERIA
4.0	I. S. CODES

1.0 SCOPE

This specification covers the erection of asbestos, C.G.I., aluminium or metal sheet covering to roof and side walls at various elevations and the fabrication and/or installation of asbestos, C.G.I or aluminium or metal gutters, flashings etc., as shown on drawings.

2.0 STORAGE OF MATERIALS

2.1 CARE & STORAGE BEFORE INSTALLATION

All materials shall be stored by the Contractor in proper way to prevent all damage. If the materials are issued at site by the Owner, the Contractor shall at the time of issue, satisfy himself about the condition of issued sheets, gutters, etc. and no complaints shall be entertained later.

The following points should be taken care of the Storing of Sheets:

2.1.1 Do not have uncovered sheets left lying in the open, Store in a covered area. If it is stored outside, cover the sheets with waterproof covers. Leave some space between the cover & the Sheetstacks, so that air circulation is possible.

2.1.2 The sheet should be stacked neatly, above the ground and in an inclined fashion/gentle sloping. This shall allow the rain water to drain off automatically.

2.1.3 It is advisable to keep each bundle of sheet, separately.

2.1.4 Do not store sheets, where people can walk over them.

2.2 HANDLING AND HUMAN TRAFFIC MOVEMENT

On large building, handling time can be reduced by lifting sheet bundles with Crane, onto the roof frame. Care must be taken such that the weight of sheet bundle is not too much that it affects the structure. Where mechanical handling facilities are not present, sheets can be un-loaded & passed on to the roof, one at a time.

Sheets should not be dragged over the ground or any rough surface. Sheets should also not be dragged over each other. Tools used for erection should be carried and not dragged over the sheets.

During erection & maintenance time, worker should careful when walking on roof. General procedure of walking on roof are :

2.2.1 When walking parallel to the ribs, walk on at least two ribs.

2.2.2 When walking across the ribs, walk close to or over the roofing supports.

2.3 FASTERS & SEALANT

The steel sheet be fastened with nominal 40 mm zinc coated or nominal 25 mm zinc-tin alloy coated, Hex head, Self-drilling screw as per As 3566-2002 class 3 fastner of approved make with EPDM washer. The fastner size shall be calculated as per the design or manufacturer's recommendations. Natural cure, Silicon sealants should be water resistant, non-corrosive, resistance to extreme temperatures, retain good flexibility and of approved make. It shall be applied at all end laps as per approval by the engineer-in-charge.

2.4 WORKMANSHIP

The workmanship shall be according to best construction practice to give a water tight finish to the satisfaction of the Engineer fixing of gutters and down pipes shall be according to IS:2527.

2.4.1 Asbestos Sheeting

Asbestos sheets of profiles as stated in the Schedule of Items, shall be fixed with minimum 150 mm end lap and side laps as per manufacturer's specification Hook bolts or J-bolts shall be 8 mm dia. at 305 centres 6 mm dia galvanised iron seam bolt and nut with G.I. flat washers and bitumen washers shall be used for stitching ridge capping, corner pieces, ventilators, north light curves etc.

2.4.2 C.G.I. Sheeting and Aluminium Sheeting

Side laps shall be 2 corrugations for roof and one corrugation for side sheeting. End laps shall be minimum 150 mm for roof and 100 mm for side sheeting. In ridges and hips where plain sheets are used the end laps shall be minimum 100 mm. Holes in C.G.I sheets shall preferably be made on the ground. The sheets should be placed on trestles and holes punched in the ridge of the corrugation from the outside inward for obtaining proper seating of limpet washers. Sheets shall be secured to sheet framing by 8 mm dia. galvanised iron hooks or J-bolts and maximum 305 mm apart. The length of the hook or J- bolts shall be to suit the sections of the bearers. Sheets shall also be bolted at the ends at every third corrugation with 6 mm dia. galvanised iron seam bolts and G.I. flat washers and bituminous washers.

2.4.3 Firbre Glass Reinforced Plastic Sheeting

This shall be of thickness and profile as mentioned in the drawing. Colour and light transmittance shall be as mentioned in drawings and or schedules. Where used in conjunction with C.G.I. or asbestos sheeting the end and side laps and fixing device shall be same as used for general sheeting. Where used in lieu of glass, the fixing shall be by means of timber or metal glazing beads as mentioned in drawing. In all cases, the installation shall be completely watertight and able to withstand the designed wind-pressure.

2.4.4 Metal sheeting

Sheeting should be fixed, strictly as per construction drawings. The maximum length of sheets should be the maximum transportable length. The number of sheets and the length of sheets to be worked out considering the minimum number of laps/joints in the roof system. The sheets and all accessories should be factory cut & then sent to site. Cutting of sheets at site should be avoided. If cutting of sheet at site is required, metal sheets should be cut by a Power saw with a metal cutting blade which leaves less redundant burr. Manufacturer's recommendations should be strictly followed. Before installation of roofing & cladding, it should be ensured that the supporting structure should be in true plans/perfect alignment, correctly placed & securely fixed. Cladding erection for each elevation

should commence at the bottom & proceed towards the top in order to ensure tight fitting laps. The installed profiled sheets have a side lap of at least one corrugation. The end lap should have sufficient overlap depending upon the slope of the roof. The end laps should use sealant so as to ensure that there is no leakage of rain water from the joints.

The General guidelines :

	Roof Slope	**End lap (min.) mm**	**End lap (max.) mm.**
(a)	Less than 1 in 4 (15^o)	150	250
(b)	Greater than 1 in 4 (15^o)	150	250
(c)	Wall	100	200

The suggested end laps & no. of fasteners used should be as per manufacturer's recommendations.

During cutting, drilling operations, the resulting small, sharp left over metallic particles or swarf can result stains on the coated steel roof. Swarfs should be removed & the Coated steel surface properly cleaned. During fastner installation, the installer should stand 90^o to the panel, facing the purlin & drive the fastner until it is tight and the washer is firmly seated. Fasteners should not be over-driven. Proper fastner driver as recommended by manufacturer should be used for self drilling screw.

3.0 ACCEPTANCE CRITERIA

The installations shall present a neat appearance and shall be checked for water tightness. The following shall be checked:

3.1 Side and end laps

3.2 Absence of cracks, holes or damages in sheet

3.3 Spacing of bolts, screws along with washer

3.4 Provision of double washers (G.I. and asbestos or bituminous washers)

3.5 Proper installation of flashing

4.0 IS CODES

The following are some of the important IS Codes relevant to this sections :

(a)	IS : 3007	:	Code of practice for laying of asbestos cement sheets.
(b)	IS : 2527	:	Code of practice for fixing rain water gutters and down pipes for roof drainage.
(c)	IS : 1626	:	Specification for asbestos cement building pipes gutters and fittings.
(d)	IS : 277	:	Specification for galvanised steel sheets (plain and corrugated).
(e)	IS : 14246	:	Continuously pre-painted galvanized steel Sheets & coils
(f)	As-3566-2002 (class 3)	:	Self-drilling screws for the building and construction industries.
(g)	As-1397	:	Steel Sheet & Strip – Hot dip zinc-coated or aluminium/zinc coated.
(h)	AS/NZS 2728	:	Prefinished/Pre painted sheet metal products for interior/ exterior building applications– Performance requirements.
(i)	IS-277-2003	:	Galvanized Steel Sheet (Plain & Corrugated).
(j)	IS-513-1994	:	Cold-rolled low Carbon Steel sheets & strips.