TECHNICAL SPECIFICATIONS FOR CIVIL WORK

1.0 GENERAL

1.1 Scope

This specification applies to the Civil, Structural, Finishing and External Development Works and building works to be executed by the Contractor. It is to be read in conjunction with and subject to the general conditions of contract and in conjunction with the drawings, the schedule of rates and such other documents as may from time to time be agreed upon as comprising part of this contract. Where these specifications are not clear, relevant BIS codes and CPWD specifications shall be followed with prior permission of Project Manager.

1.2 Clearing

The contractor shall clear the site of all rubbish and old buildings, remove all grass and low vegetation and remove all bush wood, trees, stumps of trees, and other vegetation only after consultation with the Project Manager as to which bushes and trees shall be saved. All disused foundations, drains or other obstructions met with during excavation shall be dug out and cleared.

1.3 Site Levels

The contractor shall carry out the survey of the site and shall establish sufficient number of grids and level marks to the satisfaction of the Project Manager, who shall decide on the basis of this information, the general level of the plot and the plinth.

1.4 Bench-marks

Prior to commencement of construction, the contractor shall in consultation with the Project Manager, establish several site data bench-marks, their number depending on the extent of the site. The bench-marks shall be sited and constructed so as to be undisturbed throughout the period of construction.

1.5 Site investigation

The Project Manager might have got the soil investigation done and if so, the report will be handed over to the contractor for their scrutiny. The contractor shall however inspect the site and study the findings from the trial pits or bores in order to assess the problems involved in and methods to be adopted for excavation and earthwork. The contractor shall ascertain for himself all information concerning the sub-soil conditions, Ground water table periods and intensity of rainfall, flooding of the site and all data concerning excavation and earthwork. Any extra work required on this account, nothing will be paid extra.

1.6 Setting out the work

The contractor shall set out the works and during the progress of the building shall amend at his own cost any errors arising from inaccurate setting out.

During the execution of the work contractor must cross check his work with the drawings. The contractor shall be responsible for all the errors in this connection and shall have to rectify all defects and/or errors at his own cost, failing which the Project Manager reserves the right to get the same rectified at the risk and cost of the contractor.

1.7 **Cleaning up and handing over**

Upon completion of the work all the areas should be cleaned. All floors, doors, windows, surface, etc. shall be cleaned down in a manner which will render the work acceptable to the Project Manager. All rubbish due to any reason, shall be removed daily from the site and an area of up to ten metres on the outer boundaries of the premises will be cleaned by the contractor as a part of the contract. Upon completion of the project, the contractor shall turn over to the Project Manager the following:

a) Written guarantee and certificates.
b) Maintenance manuals, if any, and
c) Keys.

1.8 **Samples**

The contractor shall submit to the Project Manager samples of all materials for approval and no work shall commence before such samples are duly approved. Samples of precast concrete panels, masonry units, building insulation, finished hardware, metal window and door frames, terrazzo flooring, kota stone, marble etc. and every other work requiring samples in the opinion of the Project Manager shall be supplied to the Project Manager, and these samples will be retained as standards of materials and workmanship. The cost of the samples shall be borne by the contractor.

Throughout this specification, types of material may be specified by manufacturers' name in order to establish standard of quality, price and performance and not for the purpose of limiting competition. Unless specifically stated otherwise, the tenderers may assume the price of 'approved equivalent' except that the burden is upon the contractor to prove such equality, in writing.

A detailed programme shall be submitted by the Contractor for the material approvals, within four weeks of the Project Manager's order to commence. The detailed programme shall include but not limited to:

Date/s of submitting the various material samples.
Date/s by which the Project Manager’s approval is required.
Date/s of placing orders on the Manufacturers/Suppliers.
Date/s of arrival of the approved material/s on to the site.

Date/s of the completion of the `Mock-ups', wherever required, and the Date/s by which the Project Manager's inspection of such `Mock-ups' should be completed and the Date/s by which the Project Manager should fully approve the said Mock-ups.

1.9 **Tests**

All materials and methods of tests shall conform to the latest rules, regulation and/or specifications of the following authorities where specified herein as applicable. Bureau of Indian Standards (BIS), British Standards Code of Practice (BS) in case no equivalent BIS is available. The Project Manager will have the option to have any of the materials tested and if the test results show that the materials do not conform to the specifications, such materials shall be rejected. A reasonable number of representative tests will be deemed to be included in the rates tendered.

1.10 **Mode of Measurements**

All measurements will be taken in accordance with IS 1200 latest issue unless otherwise specified.

1.11 <u>CONTRACTOR TO PROVIDE</u>

The CONTRACTOR shall provide and maintain at site throughout the period of works the following at his own cost and without additional cost. The cost is deemed to be included in the contract rates

1.11.1 All labour, materials, plant, tools, equipment and temporary works required to complete and maintain the works, to the satisfaction of the Engineer-In-Charge.

1.11.2 Lighting for night and also whenever and wherever required by the Engineer-In-Charge.

1.11.3 Temporary fences, guards and protective works necessary for protection of Engineer-In-Charge, Supervisors, Workmen or any other person permitted access to the site.

1.11.4 All equipments, instruments and labour required by the Engineer-In-Charge for measurement of the works and setting out.

1.11.5 A temporary weatherproof shed for the storage of required quantity of cement as directed by Engineer–In– Charge.

1.11.6 A testing room equipped with all necessary equipments, properly calibrated instruments, materials etc., to carry on the test as directed by the Engineer-In-Charge.

1.11.7 Weighing arrangements to carry out the weighing aggregates, cement, etc.

1.12 DIMENSIONS

1.12.1 Figured dimensions on drawings shall supersede measurements by scale and drawings to a large scale shall take precedence over those to a smaller scale. All dimensions shall be checked on site prior to execution.

1.12.2 The levels, measurements and other information concerning the existing site as shown on the drawings are believed to be correct. However, the CONTRACTOR shall verify them and also examine the nature of the ground. No claim or allowance whatsoever shall be entertained on account of any errors or omissions in the levels or the description of the ground level or strata, turning out different from what was expected or shown on the drawing.

1.13 MATERIALS

1.13.1 All material brought to the site of work by CONTRACTOR meant to be used in the same works, shall be as per the specification and to the approval of the Engineer-In-Charge.

1.13.2 The CONTRACTOR shall obtain the Engineer-In-Charge's approval for samples of all materials to be used in the works and shall deposit these samples with him before placing an order for the materials with suppliers. The materials brought for the works shall conform in every respect to the approved samples. Fresh samples shall be deposited with Engineer-In-Charge whenever type or source of any material changes.

1.13.3 The CONTRACTOR shall check each fresh consignment of materials as it is brought to the site of works to see that they conform in all respects to the specifications of the samples approved by the Engineer-In-Charge.

1.13.4 The Engineer-In-Charge shall get any of the materials tested to find out whether they are in accordance with the specification. The CONTRACTOR shall bear all expenses for such testing. All bills, vouchers and test certificates, which in the opinion of the Engineer-In-Charge are necessary to convince him as to the quality of the materials or their suitability shall be produced for his inspection whenever required.

1.13.5 Any materials that have not been found to conform to the specification shall be rejected and shall be removed from the site and replaced by the CONTRACTOR at his own cost.

1.13.6 The Engineer-In-Charge shall have power to direct the CONTRACTOR to purchase and use such materials from any particular source, as may in his opinion be necessary for the proper execution of the work.

1.14 STORING OF MATERIALS ON SITE

The CONTRACTOR shall store cement on site in a weather proof shed at place approved by Engineer-In-Charge. The CONTRACTOR shall store all the other materials in a proper manner to avoid contamination and deterioration, at places approved by the Engineer-In-Charge. Should the place where material is stored by the CONTRACTOR, required by ITC for any other purpose, the CONTRACTOR shall remove the material from that place at his own cost and clear the place for the use of the ITC.

1.15 WATER

The CONTRACTOR shall make his own arrangement for storing potable water, if necessary, in drum or tanks or cisterns, to the approval of the Engineer-In-Charge. Care shall be exercised to see that water is not contaminated in any way.

1.16 TESTING

The CONTRACTOR shall at his own cost, arrange for the following tests of materials to be used in the works. The test shall be carried out in laboratories approved by the Engineer-In-Charge.

1.16.1 Sand:

Before starting the work, and whenever the quality or source of sand changes and retesting is required by the Engineer-In-Charge, sand shall be tested for its salt content, organic impurities and grading.

1.16.2 Concrete Mix:

Before starting the work, samples of sand and aggregate to be used in the works shall be tested in an approved laboratory for specific gravity, absorption, grading, silt content and other impurities. The laboratory will also be required to indicate suitable mix proportions for obtaining concrete of the strengths specified.

1.16.3 Field Tests:

As frequently as the Engineer-In-Charge may require, testing shall be carried out in the field for:

1. Moisture content of sand

2. Moisture content of aggregates
3. Silt content of sand
4. Grading of sand
5. Grading of aggregates
6. Slump test of concrete
7. Concrete cube test
8. Field compaction
9. Any other test as directed by Engineer-In-Charge

1.17 WORKMANSHIP

1.17.1 All works shall be true to level, plumb and square. The corners, edges and rises in all cases shall be unbroken and neat.

1.17.2 Any work not to the satisfaction of the Engineer-In-Charge shall be rejected. The same shall be rectified, or removed and replaced with work of the required standard of workmanship at no extra cost.

2.0 SITE DEVELOPMENT AND EARTH WORK

2.1 General

This specification deals with the clearance of the Site of Works and preparation of the same to commence the proposed construction activities. Wherever applicable, this is deemed to include all preliminary works like Dismantling/Demolition, Site Clearance, General Levelling etc.

The contractor shall visit the site, inspect the same and decide for himself the nature of the ground and the sub-soil to be excavated. No claim on account of extras will be entertained in consequences of any misunderstanding or incorrect information or ignorance of the existing conditions.

2.2 Dismantling/Demolition

Existing Buildings and structures within the boundary of the site, and as indicated in the drawings or as instructed by the Project Manager, shall be carefully and gradually dismantled or demolished, as the case may be.

i) The contractor shall furnish to the Project Manager, a detailed scheme as well as a programme of these works, at least one week prior to the commencement of the actual demolition works and get the latter's approval of the same.

ii) On approval of the above programme and scheme, the contractor shall serve notices to concerned authorities, owners, etc. as and wherever applicable, informing them of the proposed demolition and get their approval of the same, prior to the demolition/dismantling.

iii) The whole of the building/structures that are to be demolished, shall be evacuated and cleared off any valuable life and/or property to the satisfaction of the Project Manager. Where required, the employer shall provide alternative arrangements to house those who have been evacuated.

iv) The site of demolition shall be well cordoned off from the other areas to the satisfaction of the Project Manager, with all-necessary warning and signals, erected in the vicinity by the Contractor.

v) Such of those parts of the building/structures that are likely to fetch some returns from the market and/or those parts which are likely to be reused elsewhere, shall be first carefully removed from the existing buildings and then stored away properly to the complete satisfaction of the Project Manager. Such parts shall include items like woodwork, built in furniture, electrical fittings, sanitary wares etc. and all others that are listed out by the Project Manager. All such valuable / reusable material shall be the property of the Project Manager / Owner.

vi) The demolition work shall then commence preferably from the top and proceed downwards, gradually. In case of buildings comprising more than one floor, the demolition shall commence from top and shall be dismantled floor by floor in such a way that all the debris are collected in the next lower floor. Dismantling of external walls/cladding shall be done from outside inwards. The dismantling of the next lower floor shall commence only after the clearance of all debris collected in that floor from the floor above, is completed.

All dismantling/demolition works shall include excavation of the ground, wherever necessary, to dismantle the existing foundations, and back filling, including compacting to the satisfaction of the Project Manager. The material used for back filling shall be as per specifications and as approved by the Project Manager.

All dismantling/demolition works shall be carried out in such a manner, so as not to cause any damage, whatsoever, to the properties or persons in the vicinity of the site. If such damages occur, the contractor shall be liable for full reinstatement, of all such damages, at his own cost.
All services, like electrical, water supply and sanitary lines/ connections, to the existing buildings or structures that are to be dismantled and/or demolished, shall be properly cut off at points as per the instructions of the Project Manager. If any such service lines are feeding adjacent plots/ sites/premises as well as within the premises, the contractor shall inform the Project Manager, well in advance, and shall follow up with the Authorities concerned, to provide necessary reconnections to the users of these service lines.

Wherever applicable, the contractor shall apply for the various permits, for executing such works as may be required, from the relevant authorities.

Disposal of demolished/dismantled materials
Demolished/dismantled materials shall **NOT** be stacked or dumped in such a manner, as to present a hazard to vehicles or pedestrians or properties or to cause blockage in drainage channels etc. In case Contractor fails to clear the malba from the site the same shall be cleared by the Owner at Contractor's risk and cost.

The contractor shall obtain necessary permission from the local Government Authorities, pay the necessary deposits, for the location and the manner in which the debris to be disposed and then carry out the disposal, as directed by the Project Manager.

Demolished/Dismantled debris shall be dumped/stacked in an area, primarily within the site, if required, subject to the approval of the Project Manager and shall cart away and dispose off, within the shortest possible time, as directed by the Project Manager.

All dismantling works shall be carried out by crow bar, chiselling or by Jack - hammering BUT IN NO CASE BLASTING OPERATION IS PERMITTED AT SITE.

All debris shall be transported from the site on daily basis during prescribed hours as approved by local authorities for transportation.

All dismantling works shall be carried out during daytime.

2.3 Classification of Soils

The earth shall be classified under the following categories and measured separately for each category:

2.3.1 Hard dense soil

Generally any soil which requires the close application of picks or jumpers or scarifiers and rippers to loosen the same such as:

1. Stiff clay, hard shale or compact moorum requiring grafting tool and/or pick and shovel.
2. Shingle and river or nallah bed boulders.

3. Lime concrete, stone masonry in lime or cement mortar below ground level.
4. Soft, conglomerate or soft laterite when the stone can be detached from the matrix with picks and shovel.
5. Existing WBM roads, pavements etc.

2.3.2 **Ordinary/Soft/Decomposed rock (not requiring blasting)**
Rock or boulders, which may be quarried or split with crowbars or wedges/picks; such as lime stone, sand stone, hard laterite, hard conglomerate or other soft or disintegrated rock.

2.3.3 **Hard rock (requiring blasting) :**
Rock which is in solid beds, which can only be removed either by wedging or chiselling, shall be treated as hard rock. An isolated boulder or detached rock, measuring one cubic meter or more, shall also be treated as hard rock, if the same cannot be removed without wedging or chiselling.
(If required, approved chemical may be used for loosening the materials).
Blasting is totally prohibited and will not be allowed under any circumstances.

2.3.4 **Authority for classification of Soils/Rocks**
The classification of excavation shall be decided by the Project Manager and his decision shall be final and binding on the contractor.

2.3.5 **Blasting**
Blasting shall not be permitted under any circumstances. Alternately chemicals can be used to split rock. The tenderer/contractor shall submit with his tender, the method which he intends to adopt for execution of the work of rock excavation. A list of specialised tools and plants to be used for rock excavation shall be enclosed.

2.3.6 **Trimming of Slopes**
All slopes shall be trimmed by hand or mechanically true to line and profile and consolidated to the Project Manager's satisfaction. Any rock or boulders appearing on the face or likely to be unstable, shall be removed and the void thereof filled with approved material and compacted.

2.3.7 **Shoring/Earth work support**
The contractor shall shore and strut the sides of excavation to the satisfaction of the Project Manager. Should there be any slips or settlement, not withstanding the shoring, the contractor shall make good the same at his own expense, with concrete or other approved material, as directed by the Project Manager. Shoring shall be removed gradually side by side with backfilling to prevent any settlement and under no circumstances, until such time as the foundation concrete has hardened enough, to take any loads brought on by the removal. Under special circumstances, shoring shall be left in place, if so directed by the Project Manager. No extra payment shall be made for shoring. The rate for the same shall be included in the excavation items.

2.3.8 **Dewatering**
All excavation shall be kept free from water from any source. The contractor shall provide and clear away on completion, all drains, pumps and other equipment, for this purpose. The contractor shall be responsible for preventing any subsidence of adjoining ground due to pumping.

Contractor shall keep site dewatered till all construction works in basement and all other areas are completed, including waterproofing. No extra amount shall be claimed by the contractor on this account and his quoted rates shall be deemed to have been included for total dewatering.

2.3.9 **Contractor to keep excavation clear**

Should any sand, mud, weed, rubbish or other materials be deposited on excavated area, by sandstorm, rain, flood, landslips or from any cause, whatsoever, such materials shall be removed by the contractor at his own expense.

2.3.10 **Back filling**

All materials used as fill shall be to the Project Manager's approval and shall be well consolidated in layers not more than 200 mm thick. Final compacting must be done just before concrete is to be laid.

All fill materials shall be compacted at a moisture content appropriate to the material being used. The compacted filling shall achieve a density, which shall not be less than 95% of the maximum dry density obtained. Filling shall be free of any wood, organic matter or any other deleterious material.

Sand, soil, gravel etc. from the excavation may be used for backfilling of pits and trenches or for making up levels subject to approval of the Project Manager and subject to selection of proper materials. The contractor shall take instructions of the Project Manager regarding the location in which each type of excavated material is to be used according to its quality.

In case the excavated materials are not approved for backfilling, either totally or in part or if their quantity falls short of the quantity required for filling, suitable materials shall be brought to site from an approved source.

2.3.11 **Disposal of surplus**

Surplus excavated materials and all excavated materials rejected for backfilling, shall be carted away from the site by the Contractor.

2.3.12 **Measurements**

i) Existing Ground Level shall be taken jointly and recorded before commencing the excavation work. Depth of excavation in cutting shall be computed from these spot levels. The G. L. shall be recorded, at maximum 5 mts interval. Average of these reading shall be taken as the average ground level for the pits.

ii) Bottom width excavation shall be measured as given in foundation drawings and details showing the width of the bedding concrete only and hence side clearance if any will not measured separately. The contractor should cover this in his rate.

iii) Diagonal ridges, cross ridges, or dead man shall be left in position shown by the Project Manager to enable accurate measurements being taken on the completion of one work. Where the ground is not uniform or where the site is required to be levelled, levels shall be taken before the start of the work and after the completion of the work and the quantity of excavation in cutting computed from these levels. These ridges or deadman shall be removed by the Contractor at his own cost after the measurements.

iv) Where soil, soft rock, and hard rock are mixed, the measurements for the entire excavation shall be computed from the levels & dimensions as described in (i) & (ii) above.

v) Excavated materials from `HARD ROCK' and SOFT ROCK shall be stacked separately, measurement reduced by 50% to allow for voids to arrive at the quantity payable under 'hard rock' and 'soft rock' respectively.

vi) The difference between the entire excavation (worked out from the levels) and the such of the quantities payable under 'hard rock' and 'soft rock' shall be paid for as excavation in all kind of soil.

vii) Wherever rock excavation is encountered, contractor will be paid only up to required level, and any extra excavation if carried out due to any reason, no payment shall be done for the extra quantity.

2.4 **Excavation in all Soils**

Excavation and/or removal of any other material on the site, shall be carried out accurately to the lines, levels and dimensions shown in the drawings or as ordered by the Project Manager, so as to allow proper and efficient concrete work and other work in clean and dry condition. The method of excavation shall be at the discretion of the Project Manager but should the dimensions of any excavation exceed those shown on the drawings or ordered by the Project Manager or should the sides collapse, the contractor shall fill such extra space with concrete or other approved material, at his own expenses.

All founding levels will be inspected by the Project Manager and suitability for bearing of the bottom shall be determined before the concrete is placed. Records of all foundation levels shall be submitted by the contractor to the Project Manager.

The final 150 mm depth of excavation shall be taken out by hand unless otherwise permitted by the Project Manager. Extra depth of excavation, if any, beyond those shown in the drawings or ordered by the Project Manager, shall be filled up with Grade 10 concrete for which payment shall not be made to the contractor.

The contractor shall excavate any soft patches or rock outcrops below the founding level and refill with M-10 concrete. The founding stratum shall be trimmed to required level and rammed to the satisfaction of the Project Manager before concrete is placed.

Foundations within any one building shall not rest on soil strata with differential bearing capacities. Strip foundations shall not be stepped along the length of the foundations. When excavating for individual footings at different levels care shall be taken not to disturb the bearing stratum of the higher foundations. The excavation bottom shall be watered as directed by the Project Manager before the foundations are laid.

2.5 **Sweet Earth**

The Sweet earth for plantation areas, shall be from an approved source and shall be mixed with natural or artificial manure, as directed by the Project Manager.

2.6 **Pre-construction Anti-termite treatment**

i) **Chemicals**

The chemicals used for the soil treatment shall be any one or a combination of the following with concentration shown against each in adequous emulsion:

Chemicals (EC's)	Concentration
Chlorpyriphos / Landane	20% EC By weight

Chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the percentage of concentration specified above, chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the

required proportion to achieve the desired percentage of concentration. e.g. to dilute chemical of 30% concentration add 59 parts of water to one part of chemical to achieve 0.5% concentration.

Chemical shall be brought to site of work in sealed original containers. The material shall be brought in at a time in adequate quantity to suffice for the whole or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Project Manager. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from Project Manager.

Hand operated pressure pump shall be used to carry out spraying operations to facilitate proper penetration of chemicals in the earth. To have proper check for uniform spraying of chemical, graduated containers shall be used. Proper check should be kept that the specified quantity of chemical is used for the required area during the operation.

ii) **Time of application**

Soil treatment should start when foundation trenches and pits are ready to take mass concrete in foundations. Laying of mass concrete should start when the chemical emulsion has been absorbed by the soil and the surface is quite dry. Treatment should not be carried out when it is raining or soil is wet with rain or sub-soil water. The foregoing applies also in the case of treatment to the filled earth surface with the plinth before laying the sub grade for the floor.

The treated soil barrier shall not be disturbed after they are formed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and completeness of the barrier system.

iii) **Treatment for masonry foundation and basements**

The bottom surface and sides (up to a height of 30 cm. from the bottom) of the excavations made for masonry foundations and basements shall be treated with the chemical emulsion mentioned above at 5 Ltrs. per Sq.m. of surface area.

iv) **Treatment to backfill earth**

After the masonry foundations and retaining walls of the basement come up, the back fill in immediate contact with the foundation structure shall be treated with the chemical emulsion at the rate of 7.5 Ltrs. per Sq.m. of the vertical surface of the sub-structure for each side. The earth is usually returned in layers and the treatment shall be carried out in similar stages. The chemical emulsion shall be directed towards the concrete or masonry surface of the columns and walls so that the earth in contact with these surface is well treated with the chemical.

v) **Treatment for RCC foundations and basements**

The treatment described in (iii) & (iv) above applies essentially to masonry foundations where there are voids in the masonry through which termites can seek entry in to the superstructure. Hence the foundation require to be completely enveloped by a chemical barrier. In the case of RCC foundations the concrete is dense being a 1:2:4 mix or richer, the termites are unable to penetrate it. It is therefore unnecessary to start the treatment from the bottom of excavations. The treatment shall start at a depth of 50 cm. below the ground level except when ground level is raised or lowered by filling or cutting after the foundations have been cast. In such cases the depth of 50 cm shall be determined from the new soil level resulting from filling or cutting mentioned above and soil in immediate contact with the vertical surface of RCC foundations. From this depth, the back fill around the columns,

beams and RCC basement walls shall be treated at the rate of 7.5 Ltrs. per Sq.m. The other details of the treatment shall be as laid down in (iv) above.

vi) **Treatment of top surface of plinth filling**

The top surface of the consolidated earth within the walls shall be treated with the chemical emulsion at the rate of 5 Ltrs. per sq.m. of the surface before the sand bed or sub-grade is laid. If the filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes up to 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm dia MS rod on the surface to facilitate absorption of the emulsion.

vii) **Treatment at junction of walls and floor**

Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from the ground level (where it has stopped with the treatment described in (iv) above up to the level of the filled earth surface. To achieve this, a small channel 3 x 3 cm shall be made at all the junctions of wall and columns with the floor (before laying the subgrade)

and rod holes made in the channel up to the ground level 15 cm. apart and the rod moved back ward and forward to break up the earth and chemical emulsion poured along the channel at the rate of 7.5 Ltrs. per Sq.m. of the vertical wall or column surface of the sub structure so as to soak the soil right to the bottom. The soil should be tamped back in to place after this operation.

viii) **Treatment to soil along external perimeter of building**

After the building is complete, the earth along the external perimeter of the building should be roded at intervals of 15 cm. and to a depth of 30 cm. The rods should be moved back ward and forward parallel to the wall to break up the earth and chemical emulsion poured along the wall at the rate of 7.5 Ltrs. per Sq.m. of vertical surfaces. After the treatment, the earth should be tamped back in to place. Should the earth outside the building be graded on completion of building, this treatment should be carried out on the completion of such grading. In the event of filling being more than 30 cm. the external perimeter treatment shall extend to the full depth of filling up to the ground level so as to ensure continuity of the chemical barrier.

ix) **Treatment for walls retaining soil above floor level**

Retaining walls like the basement walls or outer walls above the floor level retaining soil need to be protected by providing chemical barrier by treatment of retained soil in the immediate vicinity of the wall, so as to prevent entry of termites through the voids in masonry, cracks and crevices etc. above the floor level. The soil retained by the walls shall be treated at the rate of 7.5 Ltrs. per sq.m. of the vertical surface so as to effect a continuous outer chemical barrier in continuation of the one formed under (iii).

x) **Treatment of soil under apron along external perimeter of building**

Top surface of the consolidated earth over which the apron is to be laid shall be treated with chemical emulsion @ 5 Ltrs. per Sq.m. of the vertical surface before the apron is laid. If consolidated earth does not allow emulsion to seep through, holes up to 50 to 75 mm deep at 150 mm centres both ways may be made with 12 mm dia mild steel rod on the surface to facilitate saturation of the soil with the chemical emulsion.

xi) **Treatment of soil surrounding pipes, wastes and conduits**

When pipes, wastes and conduits enter the soil inside the area of the foundation, the soil surrounding the point of entry must be loosened around each such pipe waste or conduits for a distance of 15 cm. and up to a depth of 7.5 cm before the treatment is commenced. When they enter the soil external to the foundations, they shall be similarly treated unless they stand clear of the walls of the building by about 7.5 cm. for a distance of over 30 cm.

xii) **Treatment for expansion joints**

Expansion joints at ground floor level are one of the biggest hazards for termite infestation. The soil beneath these joints should receive special attention when the treatment under (V) is carried out. This treatment should be supplemented by treating through the expansion joint after the sub-grade has been laid, at the rate of 2 Litre per linear metre.

xiii) **Safety precautions**

All chemicals used for anti termite treatment are poisonous and hazardous to health. These chemicals can have an adverse effect upon health when absorbed through the skin, in haled as vapours or spray mists or swallowed. Person using or handling these chemicals should be warned of these dangers and advised that absorption through the skin is the most likely source of accidental poisoning. They should be cautioned to observe carefully the safety precautions given below:

These chemicals are usually brought to site in the form of emulsifiable concentrates. The containers should be clearly labelled and should be stored carefully so that children and pet cannot get at them. They should be kept securely closed.

Particular care should be taken to prevent skin contact with concentrates. Prolonged exposure to dilute emulsions should also be avoided. Workers should wear clean clothing and should wash thoroughly with soap and water, especially before eating and smoking. In the event of severe contamination, clothing should be removed at once and the skin washed with soap and water. If chemicals splash in to the eyes they shall be flushed with plenty of soap and water and immediate medical attention should be sought.

The concentrates are oil solutions and present a fire hazard owing to the use of petroleum solvents. Flames should not be allowed during mixing.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs, which serve as sources of drinking water.

xiv) **Spraying equipment**

A pressure pump shall be used to carry out spraying operations to facilitate proper penetration of chemicals in to the earth.

3.0 CONCRETE WORKS (PLAIN AND RCC)

3.1 Scope

This specification covers the general requirements for concrete to be used on jobs, including requirements in regard to quality, handling, and storage of materials, proportioning, batching, mixing, placing of concrete, curing, protecting, repairing, finishing, stacking the members, erection of members and testing of concrete. All concrete included in the works shall comply with the General requirements of this section of the specification except where those requirements are modified by the provisions of later Clauses relating to specialized uses for concrete in which case the requirements of those Clauses shall take precedence.

3.2 Quality Assurance Plans and Supervision:

A competent person shall be employed full time whose first duty will be to supervise all stages in the preparation and placing of the concrete. All test on materials, the making and testing of cubes and the maintenance and calibration of all mixing and measuring plant shall be carried out under his direct supervision in the presence of the Project Manager. Contractor shall set up a laboratory with all testing arrangement at site. On award of the work contractor shall submit their quality assurance plans, complete methodology & sequence of construction for all activities.

3.2.1 APPLICABLE CODES

Note: - Wherever reference is made to IS Codes, on any page of this Technical Specification (including annexures), applicable year of publication of IS Code is as stated below.

The Indian Standard Codes applicable to this section shall include but not limited to the following:

IS 383-1970	:	Coarse and fine aggregates from natural source for concrete.
IS 455-1989	:	Portland slag cement
IS 456-2000	:	Code of practice for plain and reinforced concrete.
IS 516-1959	:	Method of test for strength of concrete.
IS 1199-1959	:	Methods of sampling and analysis of concrete.
IS 1542 – 1992	:	Sand for plaster
IS 1791-1985	:	Batch type concrete mixer.
IS 2116 – 1980	:	Sand for masonry mortars
IS 2386 (Part 1) To (Part 8) - 1963	:	Methods of test for aggregate for concrete.
IS 2430–1986	:	Methods of sampling of aggregate for concrete.
IS 2505-1992	:	ete vibrators - immersion type – General Requirement.
IS 2645- 2003	:	Integral cement waterproofing compounds.

IS 2722-1964	:	Portable swing weigh batcher for concrete (Single and double bucket type)
IS 3025 (Part 1) To (Part 56)	:	Methods of sampling and test (physical and chemical) for water and waste water.
IS 3366-1965	:	Pan Vibrators.
IS 3370 (Part 1) – 1965	:	Code of practice for concrete structures for the storage of liquids: Part 1 General requirements.
IS 3370 (Part 2) – 1965	:	Code of practice for concrete structures for the storage of liquids: Part 2 Reinforced concrete structures.
IS 3370 (Part 3) - 1967	:	Code of practice for concrete structures for the storage of liquids: Part 3 Pre-stressed concrete structures.
IS 3370 (Part 4) - 1967	:	Code of practice for concrete structures for the storage of liquids: Part 4 Design tables.
IS 4082-1996	:	Stacking and storage of construction materials and components at site - Recommendations
IS 4656-1968	:	Form vibrators for concrete.
IS 4925-2004	:	Concrete batching and mixing plant.
IS 8112-1989	:	43 grade ordinary Portland cement
3- IS 9063-1978	:	Method of making, curing and determining compressive strength of accelerated cured concrete test specimen.
IS 10262- 1982	:	Recommended guidelines for concrete mix design.
IS 12330- 1988	:	Sulphate Resisting Portland cement.
IS 432 (Part 1) -198	:	Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement: Part 1 Mild steel and medium tensile steel bars.
IS 432 (Part 2) -198	:	Mild steel and medium tensile steel bars and hard drawn steel wire concrete reinforcement: Part 2 Hard-drawn steel wire.
IS 456 – 2000	:	Plain and Reinforced Concrete Code of Practice.
IS 1566 - 1982	:	Hard drawn steel wire fabric for concrete reinforcement.
IS 1786 – 1985	:	High strength deformed steel bars and wires, for concrete reinforcement.
IS 2062 – 1999	:	Steel for general structural purposes.
IS 2502 – 1963	:	Code of practice for bending and fixing of bars for concrete reinforcement.

IS 2751 – 1979	:	Recommended practice for welding of M.S.Plain and deformed bars reinforced construction.
IS 4082 - 1996	:	Stacking and storage of construction materials and components at site - Recommendations.
IS 9417 – 1989	:	Recommendations for welding cold worked bars for reinforced Concrete construction.

3.3 Materials

a) **Cement**

Cement shall in general comply the following specifications: -

i) **Types**

The cement used shall be ordinary Portland cement conforming to IS 269 (Latest revision) (IS 8112:1989 ??) of grade 43 for all works except where specifically mentioned in the Drawings, Bill of Quantities, and/or directed by the Project Manager (use of Grade 53 cement is strictly prohibited).

All cement shall be fresh when delivered. Cement shall be delivered in sound and properly secured bags or other packages ready for immediate use and shall be used direct from the bag. The contractor shall maintain for Project Manager' inspection a record of receipts and consumption of cement indicating the source, the age and the date of receipt of cement. Cement containing lumps which cannot be broken by a light touch of fingers shall not be used in the works. Admixtures shall not be used without written consent of the Project Manager.

ii) **Sources**

Cement shall be obtained from sources/vendors/authorized distributors, which are approved by the Project Manager. Makes and sources of cement shall not be varied from those used for trial mixes; should a change be unavoidable the contractor shall submit his proposals for the prior approval of the Project Manager and then carry out new trial mixes unless otherwise directed by the Project Manager. **Cement of different kinds shall not be mixed at any stage**.

iii) **Manufacturers' Test Certificates for Cement**

The Contractor shall request the cement manufacturer to forward to his site office the Certificate of conformity in accordance with IS. 269 (Latest Revision), and he shall cause a copy to be supplied to the Project Manager within 48 hours of the arrival of the certificate, which shall not be later than 14 days from the day of delivery of the relevant consignment. The test certificate shall be related to the date of delivery at site of consignment. The frequency of deliveries shall be such as to ensure that no cement is more than 3 months old when used in the works.

Tests after Delivery

Each consignment of cement supplied by ITC or CONTRACTOR shall, after delivery at site and at the discretion of the Engineer-In-Charge, be subjected to any or all of the tests and analyses, required by the relevant Indian Standard Codes. In case the cement is supplied by the ITC, the CONTRACTOR shall get himself satisfied regarding its quality before using the same in his works at his own expense. The CONTRACTOR shall carry

out and bear the cost of all tests and analyses required to ensure quality of cement before using in actual works, irrespective of the fact whether the cement is supplied by the ITC or procured by him.

Rejection

The Engineer-In-Charge/Project Manager/PMC may reject at his discretion any cement, notwithstanding the manufacturer's certificate or failing to meet the requirements of relevant IS Codes for testing of cement. He may similarly reject any cement which has deteriorated owing to inadequate protection from moisture or due to intrusion of foreign matter or any other cause. Any cement which is considered defective shall not be used and shall be promptly removed from the site by the CONTRACTOR at no extra cost to ITC

iv) **Samples of Cement**

Samples of cement to be used in the works shall be deposited with the Project Manager for his approval together with a certificate stating the name and address of the Manufacturer, the name and address of the supplier from whom it was purchased. The Project Manager may from time to time take samples of the cement being used in the works for testing.

v) **Storage of Cement**

The contractor shall provide a proper separate weatherproof store building with raised floor for cement storage on the site and shall at all times protect the cement from damp or any other deleterious influences. Each consignment of cement shall be kept separately and the contractor shall be careful to ensure the consignments are used in the order in which they are received. PM/PMC shall approve storage arrangement.

Incase cement gets affected from damp or any other deleterious influence, such cement shall not be used for construction work.

b) **Aggregates**

i) Materials used as aggregates shall be obtained from a source known to produce aggregates satisfactory for concrete and shall be chemically inert, strong, hard, durable, of limited porosity and free from adhering's, coating, clay lumps, coal residues and organic or other impurities that may cause corrosion of reinforcement or may impair the strength or durability of the concrete. Aggregates shall be tested in accordance with the requirements of IS. 383 or IS. 515 and the results of such tests shall be as hereinafter specified, the percentages being by weight unless the context indicates otherwise.

ii) Fine aggregates shall be natural sand or sand derived by crushing material like gravel or stone and shall be free from coagulated lumps. Sand derived from stone unsuitable for coarse aggregates shall not be used as fine aggregates. The caustic soda test for organic impurities shall show a colour not deeper than that of the Standard solution. The number of fine particles as ascertained by the Laboratory Sedimentation test shall not exceed 10% for crushed stones. The settling test for natural sand or crushed stone shall be made, and after being allowed to set in for three hours the thickness of the layer of silt deposited on the coarser material shall not exceed 8%.

The grading of a natural sand or crushed stone i.e. fine aggregates shall be such that not more than 5 (five) percent shall exceed 5 mm in size, not more than 10% shall pass IS sieve No. 150 not less than 45% or more than 85%

shall pass IS sieve No. 1.18 mm and not less than 25% or more than 60% shall pass IS Sieve No. 600 micron.

Only washed sand of quality and grading specified herein above shall be used. Admixture of sand obtained by crushing natural stone may be permitted by the Project Manager, provided the mixture satisfies the requirements for the fine aggregates here in above specified. But not more than one part of the sand obtained by crushing natural stone may be added to two parts of washed sand.

Sampling and testing shall be as per IS 2386 under the supervision of engineer in charge/PMC. Testing shall be carried out from laboratories approved by Engineer in charge/PM/PMC. The cost of all tests, sampling etc shall be borne by contractor.

iii) **Coarse Aggregate**

Coarse Aggregates shall be crushed stone. The pieces shall be angular, rounded in shape and shall have granular or crystalline or smooth (but not glossy) non-powdery surface. Fragile, flaky and laminated pieces, and mica shall not be present.

The "Aggregates Crushing Value" shall not exceed 45%. The amount of fine particles occurring in a free state or as a loose adherent shall not exceed 1%. When determined by the laboratory sedimentation test, after twenty four hours immersion in water. A previously dried sample of the coarse aggregates shall not have gained in weight more than 5%.

Size of coarse aggregate shall be maintained within tolerance limit of 2.5%.

The grading of coarse aggregate shall be such that not more than 5% shall be larger than 20 mm and not more 10% shall be smaller than 5 mm and not less than 25% or more than 55% shall be smaller than 10 mm.

Maximum size of coarse aggregate shall be of 20 mm unless otherwise noted.

The grading of coarse aggregate of nominal size of 40 mm shall be such that not more than 5% shall be larger than 40 mm and not more than 5% shall be smaller than 5 mm and not less than 10% or more than 35% shall be of 10 mm size.
Aggregate (Fine and Coarse) shall be thoroughly washed with clean water if so, directed by the Engineer-in-charge/Project Manager/PMC.

Fragile, flaky and laminated pieces, and mica shall not be present. Aggregate should be free from fine holes and stone should not be weathered.

Fine Aggregate

Fine aggregates shall be sharp and durable. The total percentage by weight of deleterious substances in sand shall not exceed 5% for uncrushed sand and 2% for crushed sand. The grading shall be as per IS 383. The fineness modulus shall be between 2.2 and 3.2

Sampling and Testing

The CONTRACTOR shall carry out all tests including mix designs of concrete, at his own expense, at the start of work as well as during any stage of construction as required by the Engineer-In-Charge. Test shall be carried out in accordance with IS 516 and IS 2386. Testing shall be carried out from laboratories approved by the Engineer-In-Charge. The method of sampling shall be in accordance with the requirements given in IS 2430.

3.4 **Steel Reinforcement**

The reinforcement steel shall in general comply the following specifications, these specifications shall also be binding on the contractor in case reinforcement steel is supplied by the Owner / Project Manager.

Type

Steel for bar and fabric reinforcement shall conform to mild steel of tested quality conforming to IS. 432 (Latest), or high yield strength deformed bar conforming to IS. 1786 or 1139 (Latest) as specified in the drawings. The steel shall be kept clean and free from pitting, loose rust, mill scale, oil, grease, earth, paint or any material which may impair the bond between the concrete and the reinforcement or which may cause corrosion of the reinforcement or deterioration of the concrete. Fabric reinforcement (IRC weld mesh or equivalent) shall be delivered to site in flat sheets only.

Storage of Reinforcement

Before and after bending, reinforcement shall be stored on raised racks in separate lots by size and type and protected from damage, contamination and the effects of the weather. For the purposes of identification each lot shall be marked plainly and securely by approved methods.

The CONTRACTOR shall maintain the proper records of receipt, consumption. The records shall always be accessible to the Engineer-In-Charge for verification.
The reinforcement bars shall be stored in such a way as to avoid and prevent deterioration, corrosion, bending, twisting and wrapping.
In case of any damage occurring to the materials on account of faulty storage or negligence by the CONTRACTOR, same shall be borne by the CONTRACTOR himself at his own cost.

3.4.1 <u>TESTS AFTER DELIVERY</u>

Materials supplied by the OWNER /TEIL or CONTRACTOR, shall, after delivery at site and at the discretion of Engineer-In-Charge, be subjected to any or all the tests, required by the relevant IS Codes. The CONTRACTOR shall carry out and bear the cost of such tests irrespective of the fact whether the material is procured by the OWNER/TEIL or CONTRACTOR. In any case, the CONTRACTOR shall get himself satisfied regarding its quality before using the same in his works at his own expense.

3.4.2 <u>REJECTION</u>

The Engineer-In-Charge may reject at his discretion any material, not withstanding the manufacturer's certificate or failing to meet the requirements of relevant IS Codes for testing of materials. He may similarly reject any material, which has deteriorated or corroded etc., due to improper storage, handling or transport. Defective materials shall not be used and removed from the site by the CONTRACTOR at his own expense.

3.4.3 INSPECTION

Every bar shall be inspected before assembling on the works and any defective, brittle, excessively rusted or burnt bars shall be removed. Cracked ends of bars shall be cut out.

3.4.4 BENDING

The CONTRACTOR shall prepare bar bending schedules as per details given in IS 2502 and get them approved before proceeding with cutting and bending of bars.

All bars shall be carefully and accurately bent by the CONTRACTOR, in accordance with the drawings and special care shall be taken such that:

(a) The bars shall be placed in exact positions. The bars shall not be bent or straightened in any manner that will injure the material.

(b) Bars incorrectly bent shall be used, only if means for straightening and rebinding are such as not to injure the material.

(c) No reinforcement shall be bent when in position in the works without approval whether or not it is partially embedded in hardened concrete.

(d) Hooks shall be unless stated otherwise in drawings: -

(i) Complete semicircular turn with a radius of not less than 4 and not more than 6 bar diameters plus an extension of at least 4 bar diameters at the free end.

(ii) Or 90-degree bend having a radius of not less than 4 bar diameters plus an extension of 12 bar diameters.

3.4.5 LAPPING

As far as possible, bars of the maximum length available shall be used. Laps shown on drawings or otherwise specified by the Engineer-In-Charge shall be based on the use by the CONTRACTOR of bars of maximum length. In case the CONTRACTOR wishes to use shorter bars, laps shall be provided at the CONTRACTOR's cost in the manner and at the locations approved by the Engineer-In-Charge.

As and when necessary, welded laps shall be provided as specified by the Engineer-In-Charge.

3.4.6 SPACING, SUPPORTING AND CLEANING

(a) All reinforcement shall be placed and maintained in the position, as shown on the drawings.

(b) The CONTRACTOR shall provide approved types of supports for maintaining the top bars of the slab in position during concreting. All cover blocks shall be of concrete and of the same strength as that of the surrounding concrete and properly compacted. They shall be circular in shape and not square.

(c) 18 SWG annealed steel wire shall be used as binding wire. All bars crossing one another 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.
For fusion bonded epoxy coated rebars, pvc coated G.I. binding wire of 18 SWG shall be

used.

(d) Bars shall be cleaned, before concreting commences, of all scale, rust or partially set concrete, which may be deposited there during placing of a previous lift of concrete. The bars shall be cleaned with dry gunny bags, if they are coated lightly with rust or other impurities. On no account shall the bars be oiled or painted, nor shall mould oil used on the formwork, be allowed to come in contact with the bars. Cement wash to bars shall not be permitted.

(e) During placing of concrete, the greatest care shall be taken to prevent any displacement or
bending of the bars, ties, links, stirrups or fabric.

(f) A competent steel fixer shall be in attendance on the work to adjust and correct position of any
reinforcement displaced.

(g) Reinforcement shall not be supported by wires attached, to that portion of the formwork against
which concrete is to be cast?

(h) The vertical distances required between successive layers of bars in beams, shall be maintained by the provision of steel spacer bars inserted at such intervals, that the main bars do not perceptibly sag.

(i) The cover to the reinforcement shall be, as specified in the drawings.

Welded Laps

Wherever specified, welded laps shall be provided and paid for separately unless specifically included in the item of work. No payment shall be made to the contractor for welding as per Project Manager's requirements, if the same is necessitated due to the reasons attributable to the Contractor. The welding of bars shall be carried out as per IS: 2751-1979, IS:9417-1979. Before doing welding of bars at site, the contractor shall make minimum 3 joints and get them tested in an approved laboratory at his own cost. The following precautions shall be taken:

a) If the cold twisted deformed bar has an untwisted end at lapping point, then this portion shall be cut off prior to welding.
b) Bars shall be free from rust at joints to be welded.
c) Bars shall be aligned and kept in proper axis in order to minimize crookedness in bar after welding.

3.4.7 HARD DRAWN STEEL WIRE FABRIC

(a) Hard-drawn steel wire fabric shall be of the following two types:
(i) Oblong mesh

(ii) Square mesh

(b) The fabric may be designated as per IS 1566. Alternately a complete description of the fabric may be given.

(c) When denoting the size of sheet or roll of oblong mesh fabric, the first dimension shall be the length of the main wires.

(d) The wire used in the manufacture of fabric shall be hard drawn steel wire conforming, in all respects, to the requirements of IS 432 (Part II) and suitable for welding.

(e) The fabric shall be formed by spacing the main and the cross wires, which shall be fixed at their points of intersection by electric welding. It shall be sufficiently stable to withstand normal handling in transport and during concreting, without displacement beyond the limits specified. It shall be fabricated to ensure accurate spacing and alignment of all members of the finished fabric to give substantial square or rectangular openings.

(f) Butt joints in the wires of the fabric shall be electrically welded and the joints shall be staggered.

(g) The width of the sheet or roll shall be such, as to fit in with the modular size of 10 cm module. The length of the sheet or roll shall be approved by Engineer-In-Charge.

(h) The width of the fabric shall be considered end to end distance between outside longitudinal wires, unless otherwise specified. Transverse wire shall project beyond the centre line of each longitudinal edge wire, for a distance equal to half the pitch of the main wire, unless otherwise specified.

(i) Subject to the tolerances on wire diameter specified in IS 432 (Part 2), the tolerances shall be as in IS 1566.

(j) All fabric reinforcement shall be delivered free from oil and grease, paint, scales, rust and other matter likely to adversely effect the bond with concrete. Lime wash shall be permitted. A sheet shall not contain any broken wires, and no broken cross welds in excess of four percent of the total number of welded joints, or half of the welded joints in any wire.

(k) Test Certificates shall be submitted to the Engineer-In-Charge as and when required.

3.5 Water

Type

Water for mixing concrete shall be clean and free from harmful material and comply with the requirements of Clause 5.4 of IS:456: latest.

Water shall be only from sources / bore wells approved by the Project Manager, and shall be used in a manner as directed by the Project Manager.

Testing of Water

Prior to the commencement of the works, or whenever there is a change in the source of supply or when directed by the Project Manager, the contractor shall arrange for samples of water, for mixing concrete, to be submitted to an independent Government authorised testing laboratory, acceptable to the Project Manager for tests to determine that the water complies with this specification and is satisfaction in all other respects for the manufacture of high quality concrete. Test on water sample shall be carried out in accordance with IS 3025.

3.6 Grades and Strength Requirements of Concrete

General

Concrete shall consist of the material described under previous sections, using separate coarse and fine aggregate in an appropriate combination determined in the course of the preparation of mix design described hereinafter. The overall grading shall be such as to produce a concrete of the specified quality, which will work readily in to position without segregation and without the use of excessive water. In the case of mass concrete or blinding concrete specified by nominal mix the use of "all-in" (20 mm and down) aggregate may be approved by the Project Manager. No addition of water shall be made at site. It shall be a homogeneous mix before use at site. Unless otherwise specified or mentioned in drawings, all levelling concrete, lean concrete and filling concrete shall be “NOMINAL MIX CONCRETE” and all structural concrete shall be of "DESIGN MIX CONCRETE" as defined in IS 456. However, all concrete works of grade M5, M7.5 and M10 shall always be NOMINAL MIX CONCRETE.

Nominal Mix Concrete

Nominal Mix Concrete shall be prepared without preliminary test, by adopting the proportions of materials as specified in Table I. Only graded coarse aggregates shall be used.

All the requirements of IS 456 for nominal mix concrete shall also apply.

Nominal mix concrete specified by volumetric batching shall be as per table below:

TABLE I

Concrete Mix	Cement (kg)	Sand (Liters)	Coarse Aggregate (Liters)	Quantity of Water(max.) (Liters)
1:5:10 (M5)	50	175	350	60
1:4:8 (M7.5)	50	140	280	45
1:3:6 (M10)	50	105	210	34
1:2:4 (M15)	50	70	140	32
1:1.5:3 (M20)	50	53	106	30

NOTE:

The ratio of fine to coarse aggregate shall generally be 1:2, but subject to a lower limit of 1:2.5 and an upper limit of 1:1.5. As the grading of the fine aggregates becomes finer and the maximum size of the coarse aggregate becomes larger, the ratio should be adjusted from the upper limit to the lower limit.

Slump

Only specified quantity of water shall be added to the cement and aggregate during mixing to produce concrete having a sufficient workability to enable it to be well consolidated, to be worked in to the corners of the shuttering and around the reinforcement to give the specified surface finish, and to have the specified strength. Water cement ratio shall be maintained as per IS. 456-(latest) unless specified

otherwise. When a suitable amount of water has been determined, the resulting consistency shall be maintained through out the corresponding parts of the work and tests shall be conducted to ensure the maintenance of this consistency according to the standard method of test for consistencies of concrete (slump test) as below:

Description of work	**Maximum slump in mm**.
Beams and slabs	25 to 75 mm
Columns & Walls	50 to 100 mm
Slabs & Staircase	up to 25 mm
Footings	up to 25 mm

Incase of pumpable concrete the slump & workability required for pumping the concrete shall be achieved by the contractor at his own cost. Nothing extra shall be paid for use of extra cement and / or plasticisers.

Concrete Grades

Grade of concrete used in the works shall be shown on the drawings or as directed by the Project Manager. Minimum cement contents shall be as per Is 456- (latest) or specified otherwise. The grade of concrete to be adopted in the construction shall be as follows:-

a) For mud mat, lean concrete , mass filling the concrete mix will be nominal mix concrete of 1:5:10 , 1:4:8 , 1: 3:6 (Cement : Coarse sand : 20mm Down aggregates) grade as specified in the construction drawings These mixes may be prepared using mechanical mixer .

MIXERS

The mixers shall comply with IS 1791 and shall be maintained in satisfactory operating condition. All care shall be taken to keep the mixer drum free of hardened concrete. The blades shall be replaced, when they are worn down by more than 10% of their depth. Should any mixers performance be unsatisfactory on account of wastage of material, leakage of mortar or inadequate mixing in specified time, the mixer shall be removed from operation until it is repaired to the satisfaction of the Engineer-In-Charge.

MIXING TIME

The minimum Mixing time shall be as indicated below.

Mixer Capacity	**Minimum Mixing Time**
2 cum & less	2.0 mins
3 cum	2.5 mins
5 cum	3 mins

Mixing time shall be computed from the time when all solid materials have been poured into the revolving drum with the further provision that the entire mixing water shall be added prior to the elapse of one-fourth the mixing time. Excessive mixing shall not be permitted.

RECORDS

A set of records and charts for the batching and mixing operations shall be prepared as per the directions of the Engineer-In-Charge.

ADMIXTURES

Admixtures may be used in concrete as per manufacturer's instructions, with the approval of Engineer-In-Charge based upon evidence that, with the passage of time, neither the compressive strength nor its durability is reduced. Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added by an amount not exceeding 1 1/2 percent of the weight of the cement, in each batch of concrete.
The designed concrete mix shall be corrected accordingly.

b) For all RC.C work concrete used will be controlled concrete with grade of concrete M15 or more as per construction drawings. The cement contents in the mix design shall not be lesser than as indicated in the table below. The water cement ratio and other parameters shall be strictly adhered to as per the table below:

Grade	Min. cement Kg/Cum. **(*)**	Water Cement ratio	Compressive Strength Kg/Sq.cm 7 days	28 days Field test
M - 10	170	0.6	70	100
M - 15	240	0.6	100	150
M - 20	320	0.55	135	200
M - 25	350	0.50	170	250
M - 30	400	0.45	200	300
M - 35	450	0.45	235	350

*

Note: - the actual requirements of cement contents are likely to be more than the minimum indicated. The limit has been fixed strictly from the concrete's durability point of view.

Approved admixtures may be used strictly as per IS 456-(latest) and nothing extra will be paid for the use of the same. Admixture used should not impair durability of concrete nor combine with constituents to form harmful compounds nor increase the risk of corrosion of reinforcement. Dosages of retarders, plasticisers and superplasticisers if used shall not exceed 0.5 , 1.0 and 2.0 percent respectively by weight of cementitious materials.

MIX DESIGN

DESIGN MIX CONCRETE

Concrete shall be as designated on drawings such as grade M15, M20, M25 etc. the number representing the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/mm^2 as per Table 2 of IS 456.

The CONTRACTOR shall be entirely responsible for the design of the concrete mix. The design mix shall be approved by the Engineer-In-Charge before commencing any concreting in the works. The concrete mix shall be designed so as to provide dense concrete of requisite workability having a characteristic strength not less than that specified in Table 2 of IS 456. Unless otherwise mentioned the minimum cement content for design mix concrete shall be as per Table 5 of IS 456.

The procedure given in Indian Standard Recommended Guidelines for concrete mix design
IS 10262 shall be followed.

It shall be CONTRACTOR's sole responsibility to carry out preliminary tests of specimens at his own cost as per IS 456 and IS 516. He shall furnish to Engineer-In-Charge a statement of proportions, proposed to be used for various concrete mixes. The mix so designed shall be approved by the Engineer-In-Charge within the parameters of IS 456.

As the guarantor of quality of concrete used in the construction, contractor shall carryout mix design and the mix so designed shall be approved by the Project Manager, however approval by Project Manager shall not relive the contractor from his responsibility towards quality & sufficiency of design mixes. The mix shall be designed to produce the grade of concrete having workability and a characteristic strength as indicated in the drawings. The target mean strength of concrete mix should be equal to the characteristic strength plus 1.65 times the standard deviation as indicted below.

GRADE OF CONCRETE	**STANDARD DEVIATION (N/Sq mm)**
M10, M15	3.5
M20, M25	4.0
M30, M35	5.0

Mix design shall be carried out as per SP-23 (Hand book concrete mixes) Proportion / Type of aggregates shall be made by trial in such a way so as to obtain dense possible concrete with required workability. All ingredients of concrete should be used by mass only. Contractor shall carry out the mix design and get it tested from the laboratory / Institution as per the instructions of Project Manager. Test report shall indicate

1. Workability Test of fresh concrete
2. Analysis of fresh concrete
3. Setting time of concrete < Initial setting time
   Final setting time
4. Strength Test < 7 days
   8 days

5. Cement Type

No substitutions in materials used on the work or alterations in the established proportions be made without additional test to show that the quality and strength of concrete are satisfactory. Design mix shall not be converted into volume mix under any circumstances.

3.7 Batching and Mixing

Only controlled design mix will be used for concrete with strength more or equal to M15. Volume batching may be allowed (Using mechanical Mixers) for mixes up to M10, for these leaner mixes mass volume relationship shall be checked frequently to ensure specified grading is maintained.

For the production of controlled concrete contractor shall set up, on site, automatic microchip controlled batching plant of capacity 10Cum/Hr or more, complete with silos / stock piles for cement and aggregates and D.G sets to be provided to have uninterrupted supply of concrete. The batching plant shall be tested and calibrated as per manufacturers manual and to the satisfaction of Project Manager, before starting the production of concrete, to provide uniform & consistent cement concrete mix conforming to approved mix design Batching / Mixing plant shall conform to the requirements of IS 4925 & 4926. Batching plant shall have facilities for presetting the quantities to be weighed with automatic cut off when the same is achieved and also shall be equipped with sensors to control water ratio as per moisture contents of aggregates. Printed reports of all the components of all the batches of concrete as separated by on line computer of batching plant, shall be presented to Project Manager for his approval and records. Cube samples from each batch shall be taken as per the requirement of IS 456-(latest), in the presence of Project Manager. Cubes shall be tested to record 7days & 28Days cube strength. Contractor shall be responsible for the quality of concrete which will be indicated as per the cube strength results at the end of 7days & 28days. However, 28days strength results will be treated as final.

Contractor shall make his own trial mixes for different grade and submit the report of the final design mix to be adopted for different grades to Project Manager for his approval and records (Contractor shall take in cognisance while designing concrete mixes, time required for transporting and placing the cement concrete mix at final position). Contractor shall specify along its bid the type and make of the proposed batching plant with brief specifications.

The accuracy of the measuring equipment should be within plus or minus 2% of the quantity of cement being measured and within plus or minus 3% of the quantity of aggregate, water, admixture being measured. All measuring equipment should be maintained in a clean, serviceable condition.

Mixing with mechanical mixer (for M15 or richer) will only be permitted in exceptional circumstances and then with the specific arrangement of the Project Manager. No water shall be added to mixed concrete other than the quantity of water allowed for in the mix design and incorporated in batching.

Concrete or mortar which has commenced to set shall not be remixed with additional water and in no circumstances shall such concrete or mortar be used in the work.

3.8 Concrete Admixtures & Plastisizers

Admixtures are materials added to the concrete before or during mixing with a view to modify one or more properties of concrete in plastic or hardened state. Concrete admixtures are proprietary items of manufacturers and shall be obtained from

established manufacturers having proven track record, with Project Manager's approval.

3.9 Transporting Concrete

From batching plant concrete to the location of proposed construction shall be transported through transit mixers or concrete pumps only. Contractor shall specify the make & type and number of transit mixers to be deployed along with concrete pumps with their make, capacity. The path to be used by transit mixers will be strictly as per the instructions of Project Manager. From the transit mixers concrete shall be transported to the final floor level / position through pumping or builders hoist only Concrete and mortar shall be transported speedily and deposited in its place in the works without contamination, loss of ingredients or segregation. Buckets of builder's hoist shall be large enough to contain an integral number of batches. No concrete shall be placed in the works until the contractors' proposed method of transporting concrete have been approved. When concrete is conveyed in chutes from transit mixers, the equipment shall be of such size and design as to ensue a continuous flow in the chute. The chute shall be of metal or metal lined, and if two or more lengths are used, they all shall have approximately the same slope. If the distance of the discharge end of the chute above the surface of the concrete is more than 1 metre, a spout or "elephant trunk" shall be used and the lower end positioned as near to the surface of deposit as practicable. The chute or "elephant trunk" shall be thoroughly cleaned before and after each run. The debris and any water shall be discharged outside the forms.

3.10 Concrete placement

General

Concrete, when deposited, shall have a temperature of not less than $5^{O}C$ ($41^{O}F$) and not more than $32^{O}C$ ($90^{O}F$).

The concrete shall be placed in the positions and sequences indicated on the drawings, in this specification and/or as directed by the Project Manager.

Contractor shall give adequate notice to the Project Manager/Engineer-in-charge/PMC in the prescribed format for checking RCC works one day in advance of his intention to concrete any section of the works.

Except where otherwise directed, concrete shall not be placed unless the representative of the Project Manager is present and has previously examined and approved the positioning, fixing and condition of the reinforcement or any other items to be embedded and the cleanliness, positioning and suitability of the concreting surface.

The concrete shall be deposited as nearly as possible in its final position. It shall be placed in such a manner as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork. It shall be brought up in horizontal layers not exceeding 450 mm in compacted thickness unless otherwise authorised or directed by Project Manager. Concrete shall not be placed simultaneously on each side of large horizontal specified or approved construction joints.

Shutters for walls or thin sections of considerable height shall be provided with openings or other devices that will facilitate the cleaning of the accumulation of hardened concrete on the shutters or on the metal reinforcement above the level of the concrete and the removal of concrete in the case of segregations.

Placing concrete in cold weather

No concrete shall be mixed or placed while the ambient temperature is above 40-degree C. on a rising thermometer or below 5-degree C. on a falling thermometer. The contractor shall supply an accurate maximum and minimum thermometer and hang it in an approved position on the works. Aggregates that have been exposed to frost shall not be used until completely thawed. Concrete shall be maintained by approved means at a temperature of not less than 4-degree C. during placing, and for a period of three days thereafter. All concrete placed during cold weather or when a frost is predicated or is likely to occur or occurs contrary to expectation, shall be protected from freezing by approved means.

Placing of concrete in wet weather

Concrete shall not be mixed and or placed in rainy weather or when there is likelihood of impending heavy showers. If it becomes necessary to place concrete during rainy weather, the contractor shall provide adequate protection by means of tarpaulin or similar other water proof material to immediately cover fresh concrete to prevent rain falling over it. This protection shall be left on the concrete for a period of 24 hours after placing of concrete.

3.11 **Concrete placement under water**

Concrete placed under water shall be deposited through a tremie pipe the diameter of which shall be at least 8 times the size of the largest aggregate used in the concrete mix.

The construction of and the method of handling the tremie pipes shall be approved by the Project Manager. The pipes shall be waterproof and sufficiently strong to withstand severe handling conditions and any joints must be sealed with adequate gaskets.

At the commencement of tremie work the bottom of the pipe shall be sealed before being lowered in to position. The seal shall only be broken by the concrete being placed. The concrete placed in contact with a horizontal construction joint shall have a lower proportion of coarse aggregate and a higher proportion of cement than the remainder of the concrete. The proportion shall be agreed with the Project Manager's Representative.
All underwater concrete shall be placed in still water within a cofferdam or formwork which shall extend above water level.

The proportions of the mixes shall be agreed in accordance with the strength and workability required by the specification. To allow for losses an addition of 10% of cement shall be added to mixes of concrete scheduled to be placed under water.

3.12 **Maintenance of Plant and Equipment**

The contractor shall keep Bathing Plant, weight batching machines, mixing machines, compressors, vibrators and other plant and equipment for concrete and mortar work clean, well maintained and adjusted and where appropriate, shall check the accuracy of the measuring devices at regular intervals, all to the approval of the Project Manager's Representative. Mixer blades shall be replaced when worn down by 20 mm.

3.13 **Night Work**

Concrete shall not be mixed, placed, compacted or finished during the hours of darkness, except where necessary to complete a pour. However, concreting in darkness for these exceptions shall be only after obtaining the express permission in

writing from the Architect's/Project Manager's representative and in his presence only.

3.14 **Compacting Concrete**

The concrete shall be fully compacted through out the full extent of the layer. It shall be thoroughly worked against the moulds, and around any reinforcement and other embedded items without displacing them, and in to corners of the moulds. Successive layers of the same lift shall be thoroughly worked together adjacent to the common face. The date of laying concrete shall be marked for curing and removal of form work.

Immersion vibrators shall be of approved type and shall have frequency of not less than 10000 oscillations per minute. They shall penetrate the full depth of the concrete to be vibrated and be immersed at sufficiency close spacing so that the whole volume of the concrete is satisfactorily and uniformly compacted.

Where the underlying layer is of fresh concrete, immersion vibrators shall also penetrate that layer to ensure homogeneity. Immersion vibrators shall be withdrawn slowly to prevent formation of voids. Vibrators shall not be used to work the concrete along the moulds or in such a way as to damage shuttering or other parts of the structure or to displace the reinforcement or other embedded items. Immersion vibrators shall only be operated by those who have received proper instruction and training in their use.

External vibrators shall be of approved type and shall have a frequency of not less than 3000 oscillations per minute. They shall be securely and rigidly clamped to the shuttering. External vibrators shall only be used on shuttering which is strong enough to withstand the vibration without displacement, distortion or other damage.

The contractor shall ensure that sufficient standby vibrators and ancillary equipment are available during concreting operations.

3.15 Quality Control

i) In order to ensure that the quality of materials and the mix proportions are suitable for the particular grade of concrete required are so maintained, sampling and testing shall be carried out regularly during the course or the works.

iii) As frequently as the Project Manager's representative may require and, in any case, at least once a day while concreting is in progress, the contractor shall sample and carry out a determination of the moisture content and a mechanical analysis of the fine aggregate and each nominal size of coarse aggregate shall lie within the respective limits specified.

iii) Workability testing shall be carried out in accordance with IS:456. The results shall lie within the range upon which the accepted mix design is based. Testing shall be carried out at such a frequency that the required workability is consistently achieved.

iv) Samples of concrete shall be taken at random in accordance with IS: 516 at the time and place of deposition of the concrete.

v) Notwithstanding the foregoing, additional samples shall be taken by the contractor when directed by the Project Manager. The test cube procedure shall be in accordance with IS: 516 throughout.

vi) Compliance with the specified characteristic strength shall be assumed if :

a) Each of the six cubes in a group has a test strength not less than the characteristic strength or,

b) Not more than one cube has a test strength less than the specified characteristic strength but not less than 85% of the specified characteristic strength and the average strength of the group of four test results is not less than the specified characteristic strength plus the standard deviation of the group.

3.15.1 TESTS

GENERAL

If Engineer-In-Charge feels that the materials i.e. sand, coarse aggregates, etc. are not in accordance with the specifications or if specified concrete strength is not obtained, he may order tests to be carried out on these materials in an approved laboratory as per relevant IS Codes, at CONTRACTOR's own expense.

3.15.1.1 TESTING DURING CONCRETING

(1) Grading tests shall be carried out on aggregates as per IS 2386 at intervals, as per instructions by Engineer-In-Charge.

(2) At least one Vee-bee test or slump test shall be carried out for every compressive strength test.

Cube Testing for Strength of Concrete

(a) Arrangement should be made by CONTRACTOR to have the cubes tested in an approved laboratory or in field at his own expense, with prior consent of Engineer-In-Charge. Samples shall be drawn as per IS 1199 and cubes made as per IS 516. Testing for strength of concrete shall be as per IS 456. The drawing of samples should be spread over the entire period of concreting as also over the various mixing units. The minimum frequency of sampling shall be as follows, but at least one sample shall be drawn per shift.

Volume of concrete in the work (cum)	Minimum number of samples
1 – 5	1
6 – 15	2
16 – 30	3
31 – 50	4
50 and over	4 plus one per additional unit of 50 cum.

A minimum of three cubes shall be prepared from each sample, for testing after 28 days. Additional cubes shall be taken if so advised by the Engineer–In–Charge for carrying out compressive strength check on concrete, cured by accelerated methods as laid down in IS 9013.

The specimens shall be tested as per IS 516. The 28 days compressive strength specified in IS 456 shall be the criteria for acceptance or rejection of concrete. In case the concrete is rejected, the CONTRACTOR shall be required to dismantle all such defective portion of

work, along with the other work structurally connected with the same. The Engineer-In-Charge shall solely decide the quantity of work or the part of structure to be dismantled.

(b) The test strength of the sample shall be the average of the strength of three specimens. The individual strengths of specimens shall not vary by more than ± 15 percent of the average.

(c) Standard deviation shall be calculated as per Clause 9.2.4 of IS 456.

Acceptance Criteria

(a) The acceptance criteria based on cube strengths of concrete shall be as specified in Clause 16 of IS 456.

(b) Concrete not satisfying the criteria shall be rejected at the Engineer-In-Charge's sole discretion or be subjected to testing specified in Cl. 10.3 of this specification.

(c) Concrete may also be rejected on account of honey combing, porosity, and displacement of reinforcement or construction being out of the specified tolerances.

3.15.2 TESTING OF STRUCTURES

General

Should the 28 days cube strengths results be such that the concrete does not conform to the limits set by the acceptance criteria, or should the Engineer-In-Charge have other doubts about the adequacy of the strength of the structure due to poor workmanship, honeycombing, inadequate cover, premature removal of forms, improper curing, etc., the Engineer–In–Charge may ask the CONTRACTOR to perform either in-situ testing of concrete or a load test on the structure. In-situ tests may comprise all or one of the following: Rebound hammer test, ultrasonic test, removal of cores or any other test specified by Engineer-In-Charge. The necessity for the tests and their number is at the sole discretion of Engineer-In-Charge at no extra cost to the OWNER/TEIL.

Load Test

Engineer-In-Charge shall be the sole and final authority to decide on acceptability of the structure based on the interpretation of the results. Should the structure be deemed unacceptable, Engineer-In-Charge may require the structure or part structure to be dismantled and reconstructed at no extra cost to ITC.

3.16 **Seven day cube tests**

Acceptance of concrete is based on the 28th day results. However, the contractor shall establish a relation ship between 7 days and 28 days strengths by carrying out 7 days tests at the time of performing the laboratory testing and from subsequent quality control testing. This relation ship shall be used in interpreting any further test results to predict the probable value of the corresponding 28 days cube strengths. The contractor shall without delay advise the Project Manager of any sample that appears likely to fail to meet the specification and the contractor shall take any necessary action to minimize the effect of such failure.

3.16 EXPANSION, CONSTRUCTION AND SEPERATION JOINTS

3.16 .
1 EXPANSION JOINT

Expansion joints shall be provided at the locations and to the details shown on drawings, with the joints filled with approved joint sealing compound

3.16.2 CONSTRUCTION JOINTS

(1) Construction joints shall be provided at locations as shown on drawings. Concrete shall be placed without interruption until completion of work between construction joints. Any additional construction joint needed to facilitate construction, due to constraints of equipment, time etc. shall be provided only after obtaining the prior approval of Engineer–In–Charge. The joints where provided, should be at right angles to the direction of main reinforcement and shall be kept to the minimum.

(2) The preferred location for joints in columns shall be at an elevation of 100mm to 150mm below the soffit of the deepest beam framing there. Joints shall preferably be avoided for slabs and beams. If found, unavoidable the joint shall be vertical and be located between 0.25 of span. Inclined joints shall not be permitted.

(3) Vertical joints shall be obtained through the use of a stop board having slots for the longitudinal reinforcement. A trapezoidal or triangular fillet shall be nailed to the board to form a key. Any concrete which has flowed through the stop board shall be cleaned immediately after the initial set.

(4) When concreting is taken up at a surface which has not fully hardened, the wet surface shall be scrubbed with wire brushes to remove all laitance, care being taken to avoid disturbance of aggregates. The surface shall then be thoroughly wetted, with all free water on the forms being completely removed. The surface shall then be coated with neat cement slurry and a layer of concrete of 150 mm thickness shall then be placed and well rammed against the old concrete, care being taken to fill corners and other areas having small clearances. This shall be followed by concrete placement and compaction in the usual practice.

(5) When concreting is taken up against a surface which has hardened, the surface shall be roughened using wire brushes and compressed air so as to expose the coarse aggregate. The surface shall then be cleaned, wetted, and the excess water removed from the forms. Vertical joints shall receive a coat of neat cement slurry, whereas horizontal joints shall be covered with a 10mm to 15 mm cement sand mortar having the same proportion, as the cement and sand in the concrete mix. Concreting in the usual practice shall immediately follow.

(6) Reinforcing bars shall be extended a minimum of 50 diameters beyond the construction joint. In the case of columns, the portion of columns between the stopping off level and the top of slab shall be concreted with the beam. A minimum period of two hours must elapse after depositing concrete in columns before placing of concrete in beams, girders or slabs thereon. Beams, girders, brackets, column capitals shall be considered as part of the floor system and shall be monolithically placed.

(7) Dowels for concrete work, not likely to be taken up in the near future, shall be wrapped in tar paper and burlap.

3.16.3 SEPARATION JOINTS

Separation joints shall be provided at locations shown on drawings. It shall be formed by the use of sheet of approved material and make, being stuck on the surface against which concrete is placed. All care shall be taken to prevent tearing of the sheet.

3.17 PREPARATION PRIOR TO CONCRETE PLACEMENT

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and oiled. Reinforcement and inserts shall be correctly positioned and securely held.

Necessary openings, cutouts shall be provided.

3.17.1 APPROVAL FOR POURING

Prior to pouring concrete, all arrangements, formwork, procedure for placing, with a detailed stepwise scheme of transporting and placing the concrete, mentioning equipment being deployed, location and methods shall be submitted to the Engineer–In–Charge for approval, at least 48 hours prior to concreting. CONTRACTOR shall maintain Pour Card for each pour as per TEIL format.

3.17.2 TRANSPORTATION

Concrete shall be transported from the mixer to the place of final deposit as rapidly as practicable. Care shall be taken to avoid segregation, loss of constituents and maintaining the required workability before initial setting time of cement. Buckets, containers or conveyors which are leak proof shall be used for this purpose. All such equipments shall be maintained in a good and clean condition by thoroughly cleaning them after each placement. During hot or cold weather, care shall be taken to avoid evaporation loss of water or loss of heat by suitable means.

3.17.3 PLACING

3.17.3.1 Chutes

Open troughs and chutes shall be equipped with baffles and be of short lengths to prevent segregation. The slope of the chute shall not be less than 1 vertical to 3 horizontal, nor more than 1 vertical to 2 horizontals. Chutes shall be designed such that the concrete at the lower end passes through a funnel shaped pipe or drop chute, thus causing a certain degree of remixing. Alternately they should discharge into a hopper from which concrete is further conveyed in wheel barrows. In case drop chutes are used the maximum lateral flow of the discharged concrete shall be limited to one meter. When drop chutes are swung from the vertical, the bottom two segments must be vertical in order to prevent segregation. No water shall be added at any point of the chute system to facilitate movement of concrete. Concrete shall not be permitted to fall freely for a height of more than 1.0m nor to strike the forms at an angle. All chutes, troughs and pipes shall be flushed with water at the end of each run, to keep them clean and free from coatings of hardened concrete.
The use of long troughs, chutes and pipes shall be permitted only with the approval of Engineer–In–Charge. In case the conveying arrangement produces unsatisfactory results, the Engineer–In–Charge may withdraw the permission for their use.

3.17.3.2 Placement

(a) Prior to placing concrete in foundation, all the soil surfaces upon which or against which the concrete is to be placed, shall be thoroughly compacted. The excavation shall be free from all water and debris. Soft or yielding soils shall be removed and replaced with appropriately selected soils or lean concrete compacted to the desired density. When concrete comes in direct contact with absorptive soil, the surface of the soil shall be thoroughly moistened prior to placing concrete.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut, to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

(b) No concrete shall be placed prior to the approval by Engineer–In–Charge of the formwork, scaffolding, placement of reinforcement and embedded items etc. Any water collected over formwork; bedding surfaces shall be removed.

(c) Concrete shall be discharged by means of vertical drop only. The drop height shall not exceed 1.0m in any stage of delivery.

(d) To avoid rehandling of concrete, it should be deposited as near as possible to its final position. Concrete shall be placed in horizontal layers of thickness not exceeding 300mm. In case of any segregation, it shall be corrected by shovelling aggregate into mortar and not mortar over aggregate. All care shall be taken to prevent the formation of pockets or mortar accumulation in the corners of formwork. In case they are formed they shall be removed and refilled ensuring bondage with the earlier concrete.

(e) Concrete shall be deposited in such manner so as to cause no disturbance to reinforcement or formwork. All temporary bracings for the formwork within the area to be concreted shall be removed once the level of concrete within the form ensures stability of the form. Under no circumstances shall the temporary bracing be left within the concrete.

(f) Once concreting has begun, it shall be carried out in a single continuous operation until the completion of all the work for that particular section or between construction joints has been completed. The location of construction joints, other than those shown on drawing shall be previously approved by the Engineer–In–Charge.

(g) When concrete is to be placed in roof slabs, the entire slab and beams (or portion between expansion joints for large roofs) shall be covered in one single operation without joints or breaks.

(h) Concreting in extreme temperatures, more than 40°C or less than 5°C, shall be carried out as per procedure given in IS 7861.

(i) CONTRACTOR shall fix the inserts in the concrete, at the exact level, face and location as shown in the drawing.

(j) Each placement of concrete in multiple lift work shall be allowed to set for at least 24 hours after the final set of concrete, before the start of subsequent placement.

3.17.3.3 Concreting Under Water

(a) Prior to start of work, the contractor shall submit to the Engineer–In–Charge for his approval, the proposed method, equipment, materials and proportions of mix.

(b) The concrete mix shall have a ratio of fine to coarse aggregate varying between 1:1.5 and 1:2. The additional cement content over that required for dry placement shall be a minimum of 10 percent. The concrete shall have a slump of not less than 100mm and not more than 180mm.

(c) Concrete shall be deposited continuously until it reaches the required height. Concrete shall deposited either by tremie, drop bottom bucket or by grouting as indicated in Clause 13.2.4 (a), (b), (d) of IS 456.

3.17.4 COMPACTION

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer

3.17.5 VIBRATORS

No concrete work shall commence prior to ensuring that, adequate number of vibrators are available. Each layer of concrete shall be compacted with immersion type mechanical vibrating equipment with an operational frequency between 8000 to 12000 cpm.

The use of form vibrators shall be permitted at the sole discretion of Engineer–In–Charge. The use of surface vibrators such as pan type or screed board type may be permitted by Engineer–In–Charge for slabs and sections of thickness less than 200mm. Vibrators shall in no case be used for the transport of concrete within forms.

3.17.6 METHOD OF COMPACTION

Each layer of concrete shall be compacted using the mechanical vibrators in conjunction with hand spading and tamping. Immersion type vibrators shall be inserted vertically at intervals not more than 450mm, the spacing adjusted to provide overlap with the area vibrated through insertions. The exact spacing shall depend upon the mix proportions and performance of equipment. The duration of vibration shall be limited to the time necessary to produce satisfactory consolidation without causing segregation. Minimum vibration time shall be 20 seconds per 0.1sq.m. of exposed surface. Immersion vibrators shall be withdrawn slowly when air bubbles cease to come to the surface leaving no voids. The concrete shall be worked around reinforcement, embedded items and into corners of form work.

The vibrator shall penetrate the layer being placed and also the layer below while it is still plastic, so as to avoid a cold joint between layers and ensure homogeneity and good bond. Care shall also be taken while the layer is advancing horizontally to ensure bond and homogeneity between successive batches by means of vibrators. The vibrators shall not come in contact with either the form work or the reinforcing steel. Vibrators shall not be allowed to come in contact with finished surfaces after start of initial set.

3.18 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

3.18.1 After the striking of the formwork, all concrete work shall be inspected for defects such as honey-combed surfaces, rough patches, holes left by form bolts etc. and shall be brought to the notice of Engineer-In-Charge. Engineer-In-Charge shall at his discretion, permit repair of such defective work or reject it. No extra payment shall be made for the rectification, dismantling and reconstruction of structures or part thereof.

3.18.2 Rectification of burrs and uneven faces shall be achieved by rubbing them smooth with a carborundum stone. This and other repair work shall be performed as soon as possible after the striking of forms so that the concrete has not hardened completely. Areas of segregation, stone pockets and other damaged areas shall be chipped and all loose material removed with compressed air or by washing, taking care to remove all water from the concrete. For larger repairs concrete shall be chipped out to a depth of 100-150mm. loose mortar shall be scrubbed out by using wire brushes. Based on the assessment of Engineer-In-Charge, additional reinforcement shall be spliced with existing reinforcement.

3.18.3 Bonding of old concrete with the repair material shall be achieved by wetting the chipped-out surface and either sprinkling dry cement on the wet surface or by brushing a coat of rich cement grout (1 cement: 1 sand) followed by the patch mortar for surface repairs, or patch concrete for larger repairs. Epoxy bondage of such repairs may also be permitted by Engineer-In-Charge. In such cases the epoxy shall be applied strictly in accordance with the manufacturer's instructions.

3.18.4 The cement mortar / concrete shall have the same proportions as those of the parent concrete. The source of cement shall be the same as that used in the parent concrete. The appropriate shade of concrete / mortar shall be obtained by blending with white Portland cement. The water cement ratio shall be as low as practicable and the cavity shall be filled and well compacted.

3.18.5 The repaired area shall be cured by covering with a wet saturated material, for a period of 24 hours. The subsequent curing of the repair by sprinkling water shall continue for at least 14 days.

3.19 CEMENT WASH

Surfaces which are not to be plastered nor receive any other treatment may be provided one coat of cement wash if so, directed by Engineer-In-Charge.

3.20 FINISHING

For surfaces against which backfill or concrete is to be placed, no treatment is required except repair of defective areas. For surfaces below grade, which will receive waterproofing treatment, the concrete shall be free of irregularities. For exposed concrete (exposed to view upon completion of concreting) the standard smooth finish shall be obtained with the use of lined or plywood forms having smooth and even surfaces. Upon removal of forms, the joint marks and surface defects shall be corrected and smoothened off.

3.21 PROTECTION OF IMMATURE CONCRETE

Approved means shall be adopted to prevent immature concrete from damage due to debris, backfilling, vibrations, floatation's, loading abrasion, deleterious matter or any other influence that may impair the strength and durability of concrete. Concrete placed below ground level shall be protected from falling earth. The concrete shall be prevented from coming in contact with the earth or ground water for the first 3 days after placement. The ground water level shall be lowered to an approved level by suitable means to prevent floatation or flooding at no extra cost.

3.22 HOT WEATHER REQUIREMENTS

In case of freshly placed concrete, adequate provisions shall be made to lower concrete temperatures which shall not exceed 38°C, under all weather conditions.

3.23 GROUTING

Grout shall be provided as specified on the drawings. The proportion of Standard Grout shall be such as to produce a flowable mixture, consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All structural steel elements to be grouted shall be cleaned of oil, grease, dirt etc. Grouting once started shall be done quickly and continuously. For non-shrink cementitious grouts, use of non-shrink compounds viz. ferro grout, shrink comp, or equivalent shall be in proportion of one cement, one sand and one non-shrink compound or as per manufacturer's instruction. For non-shrink free flow Non-Metallic fluid grout, cement based or Epoxy based, proprietary ready-mix products may be used. Variation in grout mixes and procedures shall be permitted if approved by Engineer-In-Charge.

3.24 INSPECTION

All materials, workmanship and finished construction shall be subject to the continuous inspection and approval of Engineer-In-Charge. CONTRACTOR shall replace materials rejected immediately at no cost to ITC.

3.25 CLEAN-UP

Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood etc. resulting from the work shall be removed and the premises left clean.

3.26 CONCRETE IN LIQUID RETAINING STRUCTURE

3.26.1 MATERIALS

3.26.1.1 General

Cement, fine and coarse aggregate, water, etc shall be as described in earlier clauses of this specification.

3.26.1.2 Water Proofing Compound

(a) Water Proofing Compounds shall be used as per the requirements given in the drawings

and as approved by Engineer-In-Charge. The compounds shall conform to IS 2645 and shall be used as per manufacturer's specifications and instructions. Test Certificates, as required by
Engineer–In–Charge to prove the effectiveness of the compound as also their non-injurious nature, with respect to concrete, shall be produced by CONTRACTOR. Compounds containing calcium chloride shall not be used.

(b) The CONTRACTOR carries out compressive test on concrete cubes where the compound has been used, as per the instructions of Engineer-In-Charge.

3.26.1.3 PVC Water Stops

(a) Water stops shall be of impermeable material, which when properly placed shall form a permanent water tight seal along the entire joint.

(b) These shall be of ribbed / serrated type with a central bulb and of width shown on drawings. The minimum thickness of water stops, without ribs / serration shall be 6mm. These shall be of approved make. The joining of two water stop lengths, where necessary shall be done strictly as per manufacturer's specification.

(c) Water stops shall be of maximum possible length, so as to keep the number of joints to a minimum.

3.26.1.4 Concrete

(a) All clauses of this specification shall be applicable along with the following additional clauses.

(b) Grading of aggregates shall be done, so as to obtain the densest possible concrete. Water cement ratio shall be kept as low as possible, consistent with the requirement of sufficient workability to produce impervious concrete. The maximum size of coarse aggregate shall be limited to 20 mm.

(c) Minimum cement content in concrete shall be as specified in IS 3370. Maximum water cement ratio shall be 0.45. Mix design shall cater for required workability and strength consistent with this ratio.

(d) The concrete placed, shall be well compacted and the joints made tight, so as to be free from honey combing and pores.

3.27 JOINTS

3.27.1 All vertical and horizontal joints shall be located as shown on the drawings. For construction joints not shown in the drawing, specific approval regarding location shall be obtained in advance from the Engineer-In-Charge. Where days work joints are formed, they shall be rebated as shown on drawings. Prior to resuming work, care shall be taken to clean out all loose stone, aggregate, nails, wooden chips or any other foreign material. All laitance shall be removed and the face of the concrete well hacked to expose the aggregate. The face shall be properly washed and a thin coat of mortar or grout (1 cement: 1 coarse sand) shall be applied just prior to resuming concreting.

3.27.2 Water stops shall be installed by embedding one half width of the water stop on either side of the joint by providing suitable supporting arrangement and as per manufacturer's specifications. Water stops shall be located accurately and supported against displacements, during concreting. Water stops shall be joined as per IS 3370 and as per manufacturers specifications at crossings and change of alignments. Jigs made from reinforcing bars may be used for supporting the water stop.

3.27.3 Joints shall be properly sealed with polysulphide sealing compounds as per manufacturer's recommendations.

3.28 ITEMS EMBEDDED IN CONCRETE

All pipe sleeves, inserts, etc. required to be embedded in the concrete, shall be accurately placed and held in position. In case any protective coatings are specified, the same shall be applied.

3.29 RENDERING

Rendering of the concrete surface in contact with liquid shall be done as per instruction of Engineer-In-Charge. Cement mortar having an approved waterproofing compound, as additive shall be applied to the concrete surface while it is still green. The concrete surface shall be made wet and hacked to obtain a good key before application of the mortar. The mortar shall be steel troweled and finished with a wooden float.

3.30 CURING

All concrete work shall be cured for a minimum period of 21 days.

3.31 HYDRAULIC TESTING

3.31.1 All liquid retaining structures shall be tested in accordance with IS 3370, to ensure water tightness. For underground, covered tanks, the maximum drop in the level of the water surface, over a period of seven days, shall not exceed 40mm.

3.31.2 Backfilling around underground structures shall be permitted only after satisfactory completion of all tests and as per instructions of Engineer-In-Charge.

3.31.3 The cost of all testing including hydraulic and structural, along with necessary equipment infrastructure and rectification if required, shall be at the CONTRACTOR's expense.

3.31.4 If the hydraulic test fails, the CONTRACTOR shall at his own cost employ suitable methods after obtaining approval by Engineer-In-Charge, to make the structure leak proof.

3.31.5 In case such attempts fail, the CONTRACTOR shall dismantle and rebuild a satisfactory structure at his own cost and within the stipulated time schedule.

3.32 **Form Work and scaffolding / Staging: -**
Form work to the fresh concrete shall be sufficiently rigid and shall be such as to prevent loss of slurry from the concrete and details and design of the form work shall

conform to IS 14687. The tolerances on the shape, lines and dimensions shall be as per CL. 11 of IS 456 –2000.

All staging and scaffolding work shall comprise of MS. Pipes / Structural steel sections with necessary coupling arrangement. (NO WOODEN BALLIES / PROPS WILL BE PERMITTED). Adequate size foundation blocks / base plates shall be provide below staging members to disperse the loads as per the founding strata.

Form work construction

i) The contractor should submit detailed drawing of the centring & shuttering and get the same approved from the Project Manager before laying concrete also he should get the centring shuttering approved in writing before start of concreting. The concreting should be done in the scientific and methodical manner so as to give a uniform finish in line and level, so that minimum rendering or plastering is done. The work found defective, should be dismantled & redone and site cleared.

ii) Form work shall be so constructed that concrete can be properly placed and thoroughly compacted. Form work shall be firmly supported and adequately strutted, braced or tied to maintain position and size. Forms shall have sufficient strength and rigidity to with stand the weight of wet concrete and necessary pressure due to ramming and vibration of concrete and movement of men material and other loads without excessive deflection from prescribed limits. It shall be capable of adjustment to the lines, levels and dimensions of the finished concrete.

iii) All form work shall be constructed to be rigid during the casting of concrete and constructed so that the surfaces adjacent to the concrete are with plus minus 6 mm or the required surfaces when supporting the concrete and sufficiently watertight to prevent loss of liquid from the concrete, and it shall be capable of being removed without shock or vibration to the concrete. Forms shall be cleaned with compressed air immediately before placing concrete to remove all rubbish. The inside faces of the form work shall be treated with a mould oil of type to be approved by the Project Manager and every care shall be taken to prevent mould oil from getting on to the reinforcement.

iv) Beams boxes shall be erected with an upward camber of 6 mm for each 3 M. of span.

v) Around the periphery of the building beyond building line , staging shall be erected by the contractor free of cost , using structural steel members duly braced to sustain all loads , with all safety measures like netting , temporary railings / parapets , platforms etc. to provide free access to external façade of the building at each floor level for construction and inspection. . Staging shall grow along with the building.

Removal of Form work (Striking Time)

Unless certainly specified in the drawing, or directed by the Project Manager, the following shall be minimum intervals of time, which should be allowed between the placing of the concrete and the striking of the mould where ordinary Portland cement is used and ambient temperature does not fall below 15 degree Celsius.

a)	Walls, column & vertical faces of all structural members	16 to 24 hours as may be decided by the Project Manager.
b)	Slab	

i)	Spanning up to 4.50 m	7	days
ii)	Spanning over 4.50 M	14	days

Note: Soffit forms of the slab may be removed after 3 days, props to be fixed immediately after removal of shuttering.

c) Beams and arches

i)	Spanning up to 6 M	14	days
ii)	Spanning 6 M to 9 M	21	days
iii)	Spanning over 9 M	28	days

Note:

1. For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Forms shall not be released un till the concrete has achieved a strength of at least twice the stress to which concrete may be subjected to after removal of the form.

2. The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

However, the Contractor shall delay the removal of shuttering as long as necessary in order to avoid damaging the work. Where shuttering to soffit is removed prior to the props this is only permissible if the design of the shuttering allows such a sequence of operations without the props being in any way disturbed. If the shuttering and props are not independent, both must be left in place until propping is no longer required.

Where shuttering to sides is removed prior to the shuttering soffit, the side shuttering shall be removed without disturbing the shuttering to the soffit.

No concrete structure shall be loaded until the concrete is at least 21 days old and only then with the approval of the Project Manager and subject to such conditions as may be imposed.

The contractor may be required to produce evidence that the concrete has attained a strength sufficient to support the live and dead loads to which that part of the structure may be subjected. This evidence shall consist of reports of compression tests made on job cured test cubes. The cost of such tests shall be borne by the contractor. The foregoing provisions of this clause shall not relieve the Contractor of his responsibility to ensure that the stability and strength of any structure or part of a structure is not impaired by the release of shuttering.

Proposals for form work

Not less than 8 days before the contractor proposes to construct any form work his detailed proposals thereof shall be delivered to the Project Manager. Proposals shall comprise all relevant information including calculations, detailed drawings, rates of placing of concrete, sequence of placing of concrete and details of any external vibrators which are proposed to be used.

No form work shall be constructed until the Contractors' proposals have been received and approved by the Project Manager.

Type of form work

Two qualities of form work shall be used i.e Rough form work and wrought form work, as noted on the Project Manager's drawings or described hereafter.

Rough form work may be constructed of sawn timber or other material as agreed by the Project Manager. The edges of the boards shall be planned or otherwise rendered grout tight. Provided it remain grout tight, rough formwork may be used any number of times. This form work shall be adopted for surfaces not exposed/buried needing no surface finish viz. Foundations/Pile caps.

Wrought form work, to all surfaces for which a smooth fair faced finish is required, shall be constructed of purpose-made metal, water proof ply wood panel, hardboard lined form work or of planed timber with edges shot so that tight joints can be formed which will prevent loss of liquid from the concrete. The use of a particular material for wrought form work shall be consistently maintained throughout the structure. The surfaces of the form work in contact with the concrete shall be smooth and free from all blemishes. The number of times wrought form work may be used shall be subject to the surfaces, joints and edges being clean and undamaged.

Surfaces of concrete
The contractor shall ensure that the finished face of concrete offers a suitable keyed surface for the application of the finishing media, e.g. plaster, sand and cement screed, etc. The contractor shall also ensure that where thin films of finished, e.g. skim coats "Snowcem", paint, etc. are to be applied that the previous provisions regarding supporting of form work are complied with, so that the concrete faces to be treated are left smooth, unblemished and true to line both vertically and horizontally and require no making good before applying the finish.

Should the contractor fail however, to comply with the provision of this Clause, he shall submit details of his proposed method of redoing the situation to the Project Manager and must obtain written consent from the Project Manager to the proposals before continuing with any further work on the affected surfaces.

Tolerances in concrete surfaces
The permissible tolerance in the surface of the hardened concrete shall not exceed the following limits:

Type of irregularity		
Departure of member planes from position and level.	+	12 mm
Variation in cross-sections	+	6 mm
Sharp changes in plane	+	2 mm
Departure from 3 M. template of any part of planes	+	3 mm

3.33 **Curing**
Canvass, Hessian or other approved screens shall be erected at all points where concrete is being placed to protect the concrete from the direct sun or from drying winds and such screens shall be kept in position until the surface of the concrete has been protected as specified in the following Clauses. The contractor shall be responsible for removing such screens and preparing surface of concrete .

As soon as possible after it has been placed and concrete shall be covered with Hessian or other approved material to protect it from the sun and all concrete surfaces shall be kept visibly wet continuously for 14 days after placement, the Hessian being kept in position throughout this period. Surfaces cast against forms shall also be kept moist and covered with Hessian for these periods if the form work is removed before the periods have elapsed.

The top surface of slab shall be kept flooded with water at all times till the curing period of 14 days is over. Columns, wall and beam sides and other surface shall be completely covered by gunny bags and kept thoroughly wet continuously for the period specified for curing. The ceiling of slabs shall be frequently sprayed with water until the end of curing period.

The contractor shall ensure that all times there is an adequate supply of fresh water available for curing the concrete.

3.34 **Examinations and Repairs**

The contractor shall not proceed with the surface finish or making good of concrete surfaces until he has received the Project Manager's written permission to do so and he shall not apply cement slurry or mortar or any other coating to the concrete surfaces as struck from the shuttering or do anything else which would hinder the proper inspection of the concrete by the Project Manager.

Concrete which is defective, has honeycombs, or which contains defective parts shall be cut out completely unless the Project Manager agrees that a repair may be satisfactorily affected. This agreement shall not preclude subsequent condemnation of the repaired work.

The method of repairing defective concrete which the contractor proposes to adopt shall be submitted to the Project Manager for his prior written agreement in each particular case.

No repairs or remedial work shall be carried out without prior inspection and instructions of the Project Manager. (No extra shall be paid to the contractor for the repair works).

3.35 **Fair face finish to concrete surfaces**

Concrete surfaces shall be finished smooth fair faced where indicated as such on the drawings. These areas shall be entirely free from honey combing, stains, fins, lipping, nail or screw marks, raised grain marks, air holes or any other imperfections. They shall also be of even texture throughout. Very slight variations between member and member may be acceptable but any such variations within a single member cannot be tolerated. The concrete faces shall not be marked with mould oil.

The form work to these areas shall be wrought form work as specified herein.

Following inspection by the Project Manager the whole surface shall be rubbed down by hand. Any surfaces with major imperfections, i.e. greater than can be easily, completely and permanently obliterated by rubbing down shall be reported immediately to the Project Manager.

Remedial work is not normally possible to the above fair faced finish surfaces and the Contractor will be required to demolish and recast defective works.

3.36 CURING

3.36.1 All concrete shall be cured by use of continuous sprays, ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material which will hold moisture for long periods. The covering should not stain or disfigure the concrete. The covering layer shall be kept continuously wet, starting 8

hours after placement (4 hours in hot weather) for the period of complete hydration with a minimum period of 14 days. The quality of curing water shall be the same as that used for mixing.

3.36.2 For the curing of flat surfaces, the curing for the first 24 hours shall be with a covering as mentioned above followed by ponding for the balance period. A minimum water depth of 25mm shall be maintained continuously.

3.36.3 Membrane curing by use of approved curing compounds may be used in lieu of moist curing with the approval of Engineer-In-Charge. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set.

3.36.4 Curing of concrete made of low heat cement, high alumina cement or super sulphated cement shall be carried out as directed by Engineer-In-Charge and as per manufacturer's specifications.

3.37 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

3.37.1 After the striking of the formwork, all concrete work shall be inspected for defects such as honey-combed surfaces, rough patches, holes left by form bolts etc. and shall be brought to the notice of Engineer-In-Charge. Engineer-In-Charge shall at his discretion, permit repair of such defective work or reject it. No extra payment shall be made for the rectification, dismantling and reconstruction of structures or part thereof.

3.37.2 Rectification of burrs and uneven faces shall be achieved by rubbing them smooth with a carborundum stone. This and other repair work shall be performed as soon as possible after the striking of forms so that the concrete has not hardened completely. Areas of segregation, stone pockets and other damaged areas shall be chipped and all loose material removed with compressed air or by washing, taking care to remove all water from the concrete. For larger repairs concrete shall be chipped out to a depth of 100-150mm. loose mortar shall be scrubbed out by using wire brushes. Based on the assessment of Engineer-In-Charge, additional reinforcement shall be spliced with existing reinforcement.

3.37.3 Bonding of old concrete with the repair material shall be achieved by wetting the chipped out surface and either sprinkling dry cement on the wet surface or by brushing a coat of rich cement grout (1 cement: 1 sand) followed by the patch mortar for surface repairs, or patch concrete for larger repairs. Epoxy bondage of such repairs may also be permitted by Engineer-In-Charge. In such cases the epoxy shall be applied strictly in accordance with the manufacturer's instructions.

3.37.4 The cement mortar / concrete shall have the same proportions as those of the parent concrete. The source of cement shall be the same as that used in the parent concrete. The appropriate shade of concrete / mortar shall be obtained by blending with white Portland cement. The water cement ratio shall be as low as practicable and the cavity shall be filled and well compacted.

3.37.5 The repaired area shall be cured by covering with a wet saturated material, for a period of 24 hours. The subsequent curing of the repair by sprinkling water shall continue for at least 14 days.

3.38 CEMENT WASH

Surfaces which are not to be plastered nor receive any other treatment may be provided one coat of cement wash if so directed by Engineer-In-Charge.

3.39 Reinforcement Fabrication

Bending Schedules

The Contractor shall submit to the Project Manager, for the Project Manager's approval, bending schedule for all the works, not less than Ten days before the contractor intends to bend the reinforcing steel.

The Approval of the Project Manager shall in no way absolve the contractor of his responsibilities under the Contract.

Programme of reinforcement details required

The Contractor shall provide a programme which gives the Project Manager at least 28 days prior notification of any reinforcement details required. The contractor shall justify the practicability of his programme to the Project Manager should it seem unreasonable before the programme be regarded as valid notification. If progress on site falls behind the contractors' programme, the issue of reinforcement details may be delayed by a period corresponding to the delay in construction.

Bending and placing reinforcement

Reinforcement shall be cut and bent to the shapes and dimensions shown on the finally agreed bending schedules in accordance with the requirements of IS: 2502 and to the tolerances set out therein.

Bending shall be carried out with an appliance which provides a continuous and uniform application of the bending deformation at every section of the bend. There shall be provision for the free movement of the surface of the bar during bending and the bends shall follow the contour of the former without peaking.

High Yield reinforcement must be bent without the application of artificial heating.

Mild steel reinforcement may be sent either hot or cold but shall not be heated to a temperature greater than 85^0 C., and if heated not cooled by quenching.

Mild steel reinforcement temporary left projecting from the concrete at construction or other joints shall not be bent out of position unless shown on the drawings or agreed by the Project Manager. Where such bending and subsequent rebinding takes place the radius of the bend shall not be less than 4 bar diameters.

Reinforcement shall be fixed without forcing in the position shown on the drawings within a tolerance of 5 mm or 5% of the minimum dimension of cross section, whichever be the greater and maintained so that it is not displaced during concreting or other operations.

Horizontal bars shall be supported sufficiently to prevent displacement. This may be plastic spacers, chairs bent from steel bar, or by concrete blocks. The method and sufficiency of the support shall be subject to the approval of the Project Manager.
Where concrete blocks are used, they shall be precast from concrete (not mortar) of the same class as the concrete in which they are to be embedded, except that the largest size of aggregate shall be 10 mm. Each block shall be secured to the reinforcement with wire or a clip embedded in the centre of the block so that, it shall

not be in contact with the shuttering or subsequently cause rust marks on the concrete. Intersections of reinforcement shall be bound together with 16 gauge annealed soft iron binding wire.

Unless otherwise noted on the drawings, no intersections of reinforcement may be fixed by welding without the permission of the Project Manager. High yield and cold worked steel shall, in no circumstances, be welded together.

Should any difficulty arise during the placing of steel in obtaining the appropriate cover, the contractor shall immediately draw the attention of the Project Manager to the difficulty and shall carryout such corrective measures as the Project Manager may suggest.

Protection of reinforcement and concrete

The Contractor shall ensure that movement of men and material subsequent to steel fixing is organized so that reinforcement is not thereby displaced.

Reinforcement left projecting from any concrete shall be protected so that there is no risk of corrosion staining to any exposed concrete surface or to any other part of the works. For this purpose, a stiff grout wash will normally be acceptable to the Project Manager, this wash shall be wire-brushed vigorously before further concrete is placed to remove any ill- bonded material.

3.40 **Precast concrete units**

Precast concrete materials and workmanship shall be in accordance with specifications unless indicated otherwise. Where different tolerances are indicated in this specification or on the drawings from these in the more severe tolerances shall apply. The units shall all be cast in properly made strong moulds to form the shapes required. For work described as "finished fair" the mould shall be lined with sheet steel or other approved material and care should be taken to ensure no damage is caused to edges or surfaces when units are removed from the moulds.

The concrete shall be of the mixes given on the drawings and shall be thoroughly vibrated in the moulds.

All precast work shall be cast under cover and shall so remain for seven days and shall be kept damp in order that the units are properly matured. No units shall be lifted until 18 days have elapsed since casting and no unit shall be erected until it has been approved by the Project Manager as free from defects.

No cracked units will be accepted for incorporation in the works.

All reinforced structural precast units shall have the tops clearly marked.

Un-reinforced precast units, such as sills and copings, shall be lightly reinforced as necessary to facilitate handling.

4.0 MASONRY WORKS

4.1 SCOPE

This specification covers the requirement for material, laying, jointing, curing, testing etc for brick masonry, stone masonry work, laterite block work, concrete block work and pitching.

4.2 APPLICABLE CODES

Note: - Wherever reference is made to IS Codes, on any page of this Technical Specification (including annexures), applicable year of publication of IS Code is as stated below.

The Indian standard codes applicable to this section shall include but not limited to the following:

IS 1077-1992	:	Common burnt clay building bricks.
IS 1121 (Part 1) - 1974	:	Methods of test for determination of strength properties of natural building stones – Part 1 Compressive Strength.
IS 1123-1975	:	Method of identification of natural building stones.
IS 1124-1974	:	Method of test for determination of water absorption apparent Specific gravity and porosity of natural buildings stones.
IS 1127-1970	:	Recommendations for dimensions and workmanship of Natural building stones for masonry work.
IS 1129-1972	:	Recommendations for dressing of natural building stones.
IS 1542-1992	:	Sand for Plaster.
IS 1597-1992	:	Code of practice for construction of stone masonry. Part-1 – Rubble Stone Masonry. Part-2 – Ashlar Masonry.
IS 1905-1987	:	Code of practice for structural use of un-reinforced masonry.
IS 2116-1980	:	Sand for masonry mortars.
IS 2180-1988	:	Heavy duty Burnt clay building bricks.
IS 2212-1991	:	Code of practice for brickwork.
IS 2250-1981		Code of practice for preparation and use of masonry mortars.
IS 2386 -1963	:	Methods of test for aggregates for concrete. (Part 1 to Part 8).
IS 2430–1986	:	Methods of sampling of aggregates for concrete.
IS 3495-1992	:	Method of test for burnt clay building bricks.
IS 3620-1979	:	Specification for Laterite Stone Block for Masonry.
IS 4082-1996	:	Stacking and storage of construction materials and components at Site – Recommendations.
IS 5454-1978	:	Methods of sampling of clay building bricks.

4.3 BRICK WORK

i) The bricks shall conform to the IS No. 1077-1992 of minimum crushing strength of 75 Kg./cm^2. (First Class)

ii) The building bricks are to be the best quality table moulded kiln burnt, patent bricks, hard sound, square with sharp arises, even and uniform in shape and colour free from cracks, stones, flaws and other defects. Samples of bricks are to be submitted to the Project Manager for approval before full quantity is ordered. All supply of brick to conform to the sample approved. No brick after 24 hours immersion in water shall absorb water more than 15% of its own weight.

iii) The cement and sand shall be as described under 'Cement Concrete' and the mortar unless specified otherwise in Bill of Quantities is to be composed of one part cement to four parts of coarse sand by volume, thoroughly mixed by hand. Hydrophobic cement used in mortar shall be thoroughly machine mixed. No mortar that has started to set shall be used in the work.

iv) The brick work shall be cured by watering and continuously kept wet for 10 days, and the work shall be well protected during rainy season.

v.) All uneven, irregular and bad brick work poor in workmanship shall be demolished if deemed necessary by the Project Manager and rebuilt by the contractor at the contractors' expenses. If necessary the contractor will have to provide wooden plug, etc. for his own work and for which there will be no special payment on that account. The work will have to be executed at any height and lift and will not form the criterion for any extra amount.

vi) Should any efflorescence be observed in brick work, it should be washed down by clean water and brick surface treated with such chemicals as are deemed necessary by the Project Manager without any extra charge and at the contractors' own expenses, till efflorescence subsides. Should the efflorescence persist, the brick work shall be demolished if deemed necessary by the Project Manager and the work rebuilt with new bricks including making good all the work disturbed without any extra charge.

<u>Sand</u>

The sand shall consist of natural sand, crushed stone sand, crushed gravel sand or combination of any of these. The sand shall be hard, durable, clean, free from adherent coatings and organic matter and shall not contain the amount of clay, silt and fine dust more than specified in IS 2116.

The sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft, fragmens, sea shells in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar.

The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand, when tested in accordance with IS 2386, shall not be more than 5% by mass in natural sand, crushed gravel sand or crushed stone sand, unless specified otherwise. For organic impurities, when determined in accordance with IS 2386, colour of the liquid shall be lighter than that indicated by the standard solution specified in IS 2386.

<u>Grading of Sand</u>

The particle size grading of sand for use in mortars shall be within the limits as specified below.

GRADING OF SAND FOR USE IN MASONRY MORTARS

IS SIEVE DESIGNATION IS 460 (PART 1)	PERCENTAGE PASSING BY MASS	REF. TO METHOD OF
4.75 mm	100	IS : 2386 (Part 1)
2.36 mm	90 to 100	
1.18 mm	70 to 100	
600 micron	40 to 100	
300 micron	5 to 70	
150 micron	0 to 15	

In case of a sand whose grading falls outside the specified limits, due to excess or deficiency of coarse or fine particles, this shall be processed to comply with the standard by screening through a suitably sized sieve and/or blending with required quantities of suitable sizes of natural sand particles or crushed stone screenings which are by themselves unsuitable. Based on test results and practical experience with the use of local materials, deviation in grading of sand may be allowed by the Engineer-In-Charge. The various sizes of particles of which the sand is composed shall be uniformly distributed throughout the mass.

Sampling and Testing

The method of sampling shall be in accordance with IS: 2430. The amount of material required for each test shall be as specified in relevant parts of IS: 2386. Any test which the Engineer-In-Charge may require in connection with this shall be carried out in accordance with the relevant parts of IS: 2386.

If further confirmation as to the satisfactory nature of the material is required, compressive test on cement mortar cubes (1:6) shall be made in accordance with IS: 2250 as instructed by the Engineer-In-Charge. These tests shall be performed, by using the supplied material in place of standard sand and the strength value so obtained shall be compared with that of another mortar made with a sand of acceptable and comparable quality.

Water

Water for masonry work shall conform to Specification No. TES-A-318.

CEMENT MORTAR

Cement mortar shall be prepared in accordance with IS 2250.

Cement mortar shall be prepared by mixing cement, sand and water in specified proportions. The mortar shall be used as soon as possible after mixing and before it has begun to set and in any case within 30 minutes after the water is added to the dry mixtures. Mortar unused for more than 30 minutes shall be rejected and removed from the site of work.

Proportioning

The unit of measurement for cement shall be a bag of cement weighing 50kgs and this shall be taken as 0.035m^3. Sand in specified proportion shall be measured in

boxes of suitable size. It shall be measured on the basis of its dry volume. In case of damp sand its quantity shall be increased suitably to allow for bulkage.

Unless otherwise specified, the cement mortar proportion shall be as follows:

Sr.No.	Thickness of Masonry Work	Cement Sand Proportion
1	115mm thk brickwork, hollow concrete block work	1:4
2	230mm thk brickwork, solid concrete block work, stone masonry work.	1:6

Mixing

The mixing of mortar shall be done in mechanical mixer operated manually or by power. The Engineer-In-Charge may, however, relax this condition at his discretion, taking into account the nature and location of work, practicability of the use of these machines. For items, where the mixers are not to be used, the CONTRACTOR shall take the approval of the Engineer-In-Charge before the commencement of work.

Mixing in Mechanical Mixer

Cement and sand in specified proportions shall be mixed dry thoroughly in a mixer. Water shall then be added gradually and wet mixing continued for at least one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of a stiff paste.

Only the quantity of mortar which can be used within 30 minutes of its mixing shall be prepared at a time.

Mixer shall be cleaned with water each time before suspending the work.

Hand Mixing

The measured quantity of sand shall be levelled on clean water tight platform, and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backward and forward, several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed with just sufficient quantity of water to bring the mortar to the consistency of a stiff paste.

SCAFFOLDING

Scaffolding shall be properly planned and designed by the CONTRACTOR. It shall be approved by Engineer-In-Charge before commencement of work. Double scaffolding, sufficiently strong so as to withstand all loads likely to come upon it and having two sets of vertical supports, shall be provided. Where two sets of supports are not possible, the inner end of the horizontal scaffolding member shall rest in a hole provided in the header course only. Only one header for each member shall be left out. Such holes shall be filled up immediately after removal of scaffolding.

The following measures shall be considered while designing and erecting of scaffolding.

(a) Sufficient sills or under pinnings in addition to base plates shall be provided particularly where scaffoldings are erected on soft grounds.

(b) Adjustable bases to compensate for uneven ground shall be used.

(c) Proper anchoring of the scaffolding/ staging at reasonable intervals shall be provided in each case with the main structure wherever available.

(d) Horizontal braces shall be provided to prevent the scaffolding from rocking.

(e) Diagonal braces shall be provided continuously from bottom to top between two adjacent rows of uprights.

(f) The scaffolding/ staging shall be checked at every stage for plumb line.

(g) All nuts and bolts shall be properly tightened.

(h) Wherever steel tubes are used care shall be taken that all the clamps/ couplings are firmly tightened so as to avoid any slippage.

xi) **Half brick masonry**: All brick work under 115 mm thick shall be reinforced with one no. 16 gauge 25mm wide MS flat in every fourth coarse. The said flat shall be cast in or securely fixed to adjoining concrete walls or columns by screw with fastener. No extra for the cost of MS flat will be paid.

xii) **Wall under structural members-** Allowance shall be made for leaving, temporarily open courses immediately below all structural members built into the walls. The open courses shall be left to permit full deflection of structural members. The open courses shall then be made good and pointed up after the structural members have been fully loaded and before the completion of the work.

CONCRETE BLOCK WORK

Constituents of Concrete Block

(a) Aggregates

For reason of economy, strength and density it is desirable to use coarse aggregate which is retained on a 4.75mm sieve and well graded sand. The maximum size of aggregate should not exceed 12.50mm. A Fineness Modulus (FM) of the combined aggregate of 3.6 to 4.20 is recommended.

(b) Admixtures

Admixtures like air-entraining agents, colouring pigments, substance to control or adjust the set and hardening of the mix, substance to improve workability of the mix can be mixed as per manufacturer's specifications with the approval of Engineer-In-Charge.

Mix of Concrete

The mix shall be 1 part of cement and 6 parts of combined aggregates by weight.

Quantity of mixing water

In block manufacturing, a mix much drier than that of ordinary field concrete is used, since the block is removed from the mould as soon as it is compressed.

Mixing

Concrete shall be mixed in a mechanical mixer till uniform distribution of material in uniform colour is obtained.

Curing

Blocks should not be removed from the place of casting for curing until they are sufficiently strong. From casting platform, the blocks are removed to a curing yard where they are frequently sprinkled with water and kept continuously moist for atleast 10 days. Curing blocks by immersing in a water tank shall not be allowed.

Physical Requirements

At the time of delivery to the work site, concrete blocks shall conform to the physical requirements as given in table below. Water absorption shall not be more than 20% by its dry weight, when soaked in cold water for 24 hours.

TABLE – 2 PHYSICAL REQUIREMENTS

Type and grade of concrete masonry unit	Minimum compressive strength, kg/cm2 of average gross area	
	Average of 3 units	Individual Unit
Hollow blocks	50	40
Solid blocks	85	70

Dimensions

The nominal sizes of concrete block are:-

Length : 400mm, 500mm, 600mm

Height : 200mm, 100mm

Width : 100mm, 150mm, 250mm and 300mm

In addition blocks may also be manufactured in half lengths of 200mm, 250mm and 300mm to correspond to the full lengths.

Tolerances

The maximum variation in the overall dimensions of the units (length, height and width) should not be more than $\pm$3mm.

Construction

Construction of block masonry shall be same as that of brick masonry explained earlier.

Joints

Same as in brick masonry. The joints are classified as horizontal and vertical joints. The thickness of the joints should be restricted to 10mm.

Curing

Green work shall be protected from rain by suitable covering. The blockwork shall be kept wet for a period of atleast 7 days commencing from 24 hours after laying.

5.0 WATER PROOFING

5.1 General

It is the intent of this specification to secure a completely water tight basement, toilets and terraces etc. guaranteed for at least 10 (Ten) years from the date of final completion. The guarantee shall be executed & extended by the Contractor & not by the water proofing agency. The contractor shall provide all materials, labour, plant, equipment, incidentals and everything necessary for securing a fully waterproof job as called for above.

All water proofing work shall be carried out by specialists as approved by the Project Manager. Installation and materials shall be as per best practices for obtaining water proof work and as recommended by the manufacturer.

Water proofing work shall be commenced only after the surface is prepared, smooth rendered, cleaned free of dirt, dust and foreign matters, inspected and approved. Compressed air shall be used for effective cleaning of all surfaces. The vents and other projections through the roof shall be made absolutely secure before flashing.

5.2 Injection method waterproofing treatment

a) **Horizontal Surface:** After the excavation and PCC levelling course, water proofing course shall be laid consisting of cement mortar 1:3 (1 cement:3 sand) and mixed with Acrylic water proofing chemicals and embedding aggregate by hand pack at random in two layers each of 25mm thick thus the total water proofing course shall be about 50mm thick. After the necessary curing, and fixing raft reinforce cement in partition provide 20 mm pipe sleeves at 1.2 m c/c on both ways by tying it with reinforcement in such a manners to ensure that the bottom end of the pipe remain free from getting chocked and the length of the pipes shall be that of total thickness of the raft plus 25 mm above to protrude from the surface of the raft.

After concreting the raft, grouting Acrylic based waterproofing chemical mixed with neat cement slurry through the pipe sleeves shall be carried and for the required period. The projected pipe ends shall be cut after grouting the mouths. The same procedure shall be adopted for all joints around the column wall joints.

b) **Vertical Surfaces**: The vertical surfaces shall be treated by making holes on the surface at 1.20 m centre to centre on both ways and also at 0.75 m along construction joints, corners and fixing nozzles of 20 mm dia pipe and inject Acrylic based chemicals mixed with neat cement slurry as explained above. After grouting the pipe, nozzles shall be removed and the packets shall be made good. The external surface of the walls shall be neatly plastered with cement mortar (1:3) admixed with Acrylic Chemicals of 12 to 15 mm thick.

5.3 Roof And Sunken Area Water Proofing (Brick Bat Coba)

Brick bat coba treatment shall be got done from an approved agency. The surface should be prepared and construction joint if any are to be raked and cleaned. Cement slurry mixed with approved chemical compound is to be spread on the surface so as to fill the undulation and other porous areas.

20 mm thick cement mortar mixed with approved chemical in cement mortar 1:4 (1 cement : 4 coarse sand) is laid over the prepared surface.

A layer of brick bat is laid over the mortar to required slope. The joints between the brick bats should be kept 15-25 mm wide. These joints be filled with cement mortar 1:4 mixed with specialized chemical compound as approved by the Project Manager. Curing is done continuously for two days.

The top surface should be finished smooth with 20 mm thick cement mortar (mixed with specified quantity of approved chemical). Curing of the treatment should be done for two weeks.

The side wall shall be provided with 20 mm thick cement plaster 1:4 mixed with specialized chemical compound upto a height of 30 Cm. A 20 mm thick gola with brick bats shall be provided and finished with cement mortar 1:4 mixed with approved chemicals compound. The gola shall be cured continuously for two weeks. The work shall be got done from a specialized agency duly approved by the Project Manager.

5.4 **Tapecrete Waterproofing**

All the chasings or cuttings in the floors and walls shall be carried out prior to the commencement of the treatment. The prepared surface than shall be plastered with 12mm thick cement mortar 1:4 mix (1 cement : 4 coarse sand), mixed with `CICO' admixture, as per manufacturers' specifications. The plastering shall be carried out throughout the sunk portion and carried up to all sides of the walls. The specialist then shall carry out `TAPECRETE' waterproofing treatment comprising of 3 coats of tapecrete with Ist coat of tapecrete mixed with grey cement in proportion of 1:2 (1 part tapecrete : 2 grey cement), 2nd coat of tapecrete mixed with grey cement and silica sand in proportion of 1:2:1.5 (1 Tapecrete : 2 grey cement : 1.5 silaca sand) , 3rd coat of tapecrete mixed with grey cement in proportion of 1:2. After the first coat of Tapecrete all corners, junctions, joints of pipes and masonry to be sealed with Epoxy putty. The treatment is laid underneath and behind all pipes. The specification on verticals is taken 150mm above the finished floor level and to full height where tubs/wash basin and WC are being fixed. The top surface shall be protected with 12mm thick plaster in cement mortar 1:4 mix (1 cement : 4 coarse sand).

5.5 Terrace Waterproofing with Insulation

Wherever specified, waterproofing treatment may be carried out, over areas as directed by the Project Manager.

The waterproofing treatment shall commence with applying Ist course of primer comprising of blown grade bitumen in the ratio 60:40 by weight. The 2nd, 4th, 8th and 10 th coarse shall be blown grade bitumen conforming to IS:702 or residual grade bitumen conforming to IS:73 or an approved proprietary bituminous conforming to IS:73 or an approved proprietary bituminous compound, at the rate of 1.5, 1.5, 1.5 and 1.7 Kg. per Sq.mt. area respectively. The 3rd, 5th and 9th coarse shall comprise of APP Polymeric Polyethylene felt with 75 mm x 100 mm side and end laps. The 6th coarse of 50mm thk Expanded Polystyrene of 24 Kgs/Cum density. The 7th coarse of Bituminised Kraft paper with 150mm overlapped sealed with bitumen and spot stuck.

For vertical surface a layer of hussian felt, fibre glass tissue and 250mm wide APP Polymeric Polyethylene felt each layer laid in hot asphalt over a coat of bituminous primer with 75mm & 100mm side & end laps respectively including 50mm deep chase cut in walls & tucking the water proofing. The vertical waterproofing overlaps with horizontal water proofing by 100mm.

Immediately after the waterproofing causes has been laid, it shall be covered with 75mm thick M15 grade concrete with providing and fixing weldmesh fabric of size 150x150x2.25mm including cutting, straightening and welding with each other wherever required, on horizontal surface. Provision of Khurrahs 450x450mm/ 300x300mm with average minimum thickness of 50mm cement concrete 1:2:4 to be

made. The water- proofing course on the vertical shall be protected with a 115mm thick cladding of brick masonry to be measured and paid separately.

5.6 Deck Slab Waterproofing

For horizontal surfaces to be executed as per 5.5 of Terrace Water Proofing specification minus the Expanded Polystyrene and Bituminised Kraft paper plus a layer of protective hessian based felt type 3 grade-I laid with hot asphalt with 75mm & 100mm side & end laps & further sealed with hot bitumen.

For vertical surfaces a layer of hessian based felt & two layers of APP Polymeric Polyethylene felt & finally covered & protected with a layer of hessian based felt each layer laid with hot mineral asphalt over a coat of bituminous primer with 75mm & 100mm side & end laps including 50mm deep chase cut in walls & tucking the water proofing.

6.0 WOOD WORKS
7.0 FLOORING/ CLADDING WORKS

7.1 General

All flooring shall be laid to the best practice known to the trade. The flooring shall be laid to the level except where slopes are called for on the drawings in which case the slopes shall be uniform and so arranged to drain in to the indicated outlets.

Particular care shall be exercised to ensure that all flooring, skirting and dado are perfectly matched for colour and finish. Sufficient extra tiles (not less than 5%) shall be cast/ordered to ensure an adequate supply of matched floor tiles. The contractor shall furnish for approval by the Project Manager, samples of each type of floor finish.

7.2 Cement Concrete flooring (IPS Flooring)

Indian patent stone flooring shall be 40mm or of specified thickness and laid in two layers, bottom layer 28mm thick or as specified in 1 part of portland cement, 2 parts of coarse sand and 4 parts of crushed stone aggregate 12.5mm down well graded machine mixed with not more than 5.5 gallons of water for each bag of cement and top layer 6mm thick in one part of portland cement, 2.5 parts of selected crushed stone chips with just enough sand maximum part to make workable mix, machine mixed with not more than 5 gallons of water. Top layer to be laid before the bottom layer has hardened. Flooring shall be laid in squares or bays as directed and each layers shall be well compacted by ramming with heavy teak wood floats. The top shall be brought to a smooth and even surface free from blemishes and finished smooth with neat cement by steel trowelling. The flooring shall be kept wet for seven days for curing.

Where ironite/hardonite topping is specified in the "Bill of Quantities" the bottom layer shall be 50mm thick or in the item of B.O.Q. and the top layer shall be 12mm thick mixed with ironite/hardonite as per manufacturers specification and finished fair.

7.9 VACCUM DEWATERED CONCRETING/TREMIX FLOORING

PREPARATION

1. The surface to receive flooring shall be clean, free from dirt and free from foreign material.
2. Any undulations or mortar remaining on the floor shall be trimmed.
3. Base course shall be trimmed.
4. The base shall be cleaned and watered before laying the floor.
5. Work includes at all depths and heights.
6. The finished surface shall be kept wet for a maximum period of one week.

CONCRETING

General

1. Concreting shall have a concrete base of M20 of specified thick.
2. Flooring shall have hard top on the concrete base.
3. Flooring shall be laid in strips, the size of which is mentioned on the drawings.

Materials

Cement - 43 grade OPC conforming to IS 8112

Sand - River sand conforming to IS 383
Aggregate - Max. size 10 to 20mm conforming to IS 383
Water - Potable conforming to IS 383
Floor hardener (Optional) - @3kG/Sqm

Execution

1. Mix cement, sand and aggregates as per grade M20 thoroughly with water to get an appropriate consistency.
2. Prepared concrete shall be laid immediately after mixing.
3. The base shall be free from water and other foreign materials, dust and dirt.
4. A coat of cement slurry of the consistency of thick cream shall be brushed on the surface of the base course.
5. The concrete shall then be spread over this base evenly and leveled carefully.
6. Low areas shall be filled with concrete and humps removed. Devacumisation shall be done for removing the voids.
7. The whole concrete surface shall be leveled, compacted by ramming and trowelling.
8. Prepared surface shall be allowed to set.
9. **Hardner screed**
   a) Hard top to be prepared as per the specifications with Nitohardner and one part of dry cement.
   b) The hard top shall be provided over concrete base immediately after it is set, compacted and leveled with a steel trowel.
   c) The surface shall be trowelled to bring the hardener coat to a leveled surface.
   d) Excessive trowelling shall be avoided.
   e) After the initial set, further compaction shall be done by steel trowelling.
   f) Final brushing shall be made before the floor top becomes too hard.

CURING

1. Curing shall commence as soon as the surface is hard enough to receive the water.
2. The surface shall be covered with sacks or sand and shall be kept continuously wet for a period of at least one week.

8.0 FINISHING WORKS

8.1 General

8.1.1 All plaster work shall be of the best workmanship and in strict accordance with the dimensions of the drawings. All plastering shall be finished to true levels including plumbs, without imperfections, and square with adjoining work. It shall form proper foundations for finishing materials such as paint etc. Masonry and concrete surface to which plaster is to be applied shall be clean, free from efflorescence, sufficiently rough and keyed to ensure proper bond.

8.1.2 Wherever directed all joints between RCC frames and masonry walls, shall be expressed by a groove in the plaster. This groove will exactly coincide with the joint beneath. At the corners of all windows and doors or other openings and wherever instructed, 24 gauge expanded galvanized metal mesh strips 300 mm wide shall be placed diagonally to prevent plaster cracks.

8.1.3 Where grooves are not called for, the joint between concrete and masonry in filling, chasing for conduits, pipes, boxes etc. shall be covered by 24 gauge expanded galvanized metal strips, 300 mm wide installed before plastering. The contractor shall supply all necessary labour, material, tools and scaffolding necessary for the completion of the work detailed. He shall be responsible to take proper precautions to all works from damage. Any work rejected through non-compliance with the specifications or damaged work shall be removed and replaced at the expense of the contractor.

8.1.4 All chasing, installation of conduits, boxes, etc. shall be completed before any plastering is commenced on a surface. Chasing or cutting of plaster will not be permitted. Broken corners shall be cut back less than 150 mm on both sides and patched with plaster of Paris as directed. All corners shall be rounded to a radius. Contractor shall get samples of each type of plaster work approved by the Project Manager.

8.1.5 The materials used for plastering shall be proportioned by volume by means of gauge boxes. Alternatively it may be required to proportion the materials by weight.

8.2 Plaster Work

8.2.1 The joints in the brick work, concrete blocks, shall be raked to a depth of 15 mm while the masonry is green. Concrete surfaces to receive plaster shall be suitably roughened. All walls shall be washed with water and kept damp for 10 hours before plastering.

8.2.2 The plaster unless specified otherwise shall be average of 15 mm thick on walls and minimum 6 mm thick for the ceiling. The finished texture shall be as approved by the Project Manager. The mix for plaster unless otherwise specified, shall be one part cement and four parts sand, to walls and one part cement, 3 parts sand to ceiling.

8.2.3 The interior plaster shall be applied in one coat only. The surface shall be trowelled smooth to an approved surface. All plaster work shall be kept continuously wet for seven days.

8.2.4 The external plaster shall be minimum 20 mm. Preparations of walls to receive plaster work shall be the same as in internal plaster. Both layers of all external plaster shall be waterproofed with approved water proofing powder added to cement

in proportion of 1.5 Kg. to 50 Kg. of cement as per the manufacturers' instruction, for both the coats.

8.2.5 For sand faced cement plaster, the finishing coat shall be in cement mortar 1:3, sand used shall be of selected colour, properly graded and washed so as to give a grained texture. Finishing plaster coat shall be 8 mm thick, uniformly applied and surface finished with special rubbing by sponge pads and other tools and recommended by the Project Manager.

8.2.6 For rough cast plaster, the backing shall be floated with 3 mm thick cement mortar 1:4 with fine sand, spread in small areas not exceeding 2 Sq.mt. at a time. While this coat is still wet, the rough cast containing a mixture of 1 part of cement, 2 parts of fine sand and 1 part of gravel, 3 to 6 mm size, shall be dashed on the floating coat, to a uniform thickness of 15 mm thick and finished even.

9.0 MISCELLANEOUS WORKS

9.1 STRUCTURAL STEEL WORK

9.1.1 SCOPE

This specification covers the requirements for material, fabrication, assembly, testing, transportation, erection of all types of structure steelworks consisting of columns, beams, trusses, lattice girders, pipe racks, pipe supports, trestles, masts, galleries, monorails, gantry girders, platforms, stairs, ladders, handrails, purlins, side runners, equipment supporting structures, guide structure (for stacks, towers/columns), etc for general construction work.

The scope of work shall include but not limited to:

(a) Preparation of detailed shop fabrication drawings based on design drawings.

(b) Design of connections (if required) and preparation of complete bill of materials.

(c) Preparation of structural erection/assembly drawings to suitable approved scale showing all dimensions, size of members, location, thickness of structural parts, gussets, marking, number, diameter, length and bolt locations, centre of gravity and back mark lines, slopes, other accessories, erection marking etc. complete.

(d) Straightening of raw steel, if necessary prior to fabrication.

(e) Supply of bolts, nuts, lock nuts, flat/spring washers, welding electrodes.

9.1.2 APPLICABLE CODES

Note: - Wherever reference is made to IS Codes, on any page of this Technical Specification (including annexures), applicable year of publication of IS Code is as stated below.

The Indian Standard Codes applicable to this section shall include but not limited to the following:

IS 800 - 1984 : Code of practice for general construction in steel.

IS 806 - 1968	:	Code of practice for use of Steel tubes in general building construction.
IS 808 -1989	:	Dimensions for hot rolled steel beam, column, channel and angle sections.
IS 813 - 1986	:	Scheme of Symbols for welding.
IS 814 - 2004	:	Covered electrodes for manual metal arc welding of Carbon and Carbon Manganese Steel.
IS 816 - 1969	:	Code of Practice for use of metal arc welding for general construction in mild steel.
IS 817 - 1966	:	Code of Practice for training and testing of metal arc welders.
IS 818 - 1968	:	Code of Practice for safety and health requirements in electric and gas welding and cutting operations.
IS 819 - 1957	:	Code of Practice for resistance spot welding for light assemblies in mild steel.
IS 822 - 1970	:	Code of Practice for Inspection of Welds.
IS 919 (Part 1) and (Part 2) – 1993	:	ISO System of limits and fits.
IS 1024 - 1999	:	Code of Practice for use of welding in Bridges and Structures subject to dynamic loading.
IS 1149 – 1982	:	High tensile steel rivet bars for structural purpose.
IS 1161 – 1998	:	Steel tubes for structural purpose.
IS 1182 - 1983	:	Recommended practice for radiographic examination of fusion welded butt joint in steel plates.
IS 1239 (Part 1) - 2004	:	Mild steel tubes, tubular and other wrought steel fittings Part 1 Mild steel tubes.
IS 1239 (Part 2) - 1992	:	Mild steel tubes, tubular and other wrought steel pipe fittings. Part 2 Mild steel tubular and other wrought steel pipe fittings.
IS 1261 - 1959	:	Code of Practice for Seam Welding in Mild Steel.
IS 1323 - 1982	:	Code of Practice for Oxyacetylene welding for Structural Work in Mild Steel.
IS 1363 (Part 1) to (Part 2) - 2002.	:	Hexagon head bolts, screws and nuts of product grade C (Size range M5 to M64).
IS 1364 (Part 1) to	:	Hexagon head bolts, screws and nuts of product grades A

(Part 5) - 2002		& B (Size range M1.6 to M64).
IS 1367 (Part 1) to (Part 20)	:	Technical supply conditions for Threaded Steel Fasteners.
IS 1608 - 1995	:	Mechanical testing of metals – tensile testing.
IS 1852 - 1985	:	Rolling and cutting tolerances for hot rolled steel products.
IS 2016 - 1967	:	Plain Washers.
IS 2062 - 1999	:	Steel for general structural purposes.
IS 2595 - 1978	:	Code of practice for radiographic testing.
IS 2629 - 1985	:	Recommended Practice for Hot Dip Galvanizing on Iron and Steel.
IS 2633 - 1986	:	Methods of Testing Uniformity of coating of Zinc coated articles.
IS 3443 - 1980	:	Crane rail sections.
IS 3460 - 1991	:	Knurled nuts.
IS 3502 - 1994	:	Steel chequered plates.
IS 3613 - 1974	:	Acceptance tests for wire flux combination for submerged arc welding.
IS 3640 - 1982	:	Hexagon fit bolts.
IS 3658 - 1999	:	Code of practice for liquid penetrant flaw detection.
IS 3757 - 1985	:	High strength structural bolts.
IS 4000 - 1992	:	High strength bolts in steel structures – Code of Practice.
IS 4218 - (Part 1 to Part 6)	:	ISO Metric Screw Threads.
IS 4353 - 1995	:	Submerged arc welding of mild steel and low alloy steels – Recommendations.
IS 5334 - 2003	:	Code of practice for magnetic particle flaw detection of welds.
IS 5369 - 1975	:	General requirements for plain washers and lock washers.
IS 5370 - 1969	:	Plain washers with outside diameter 3 x inside diameter.
IS 5372 - 1975	:	Taper washers for channels (ISMC).
IS 5374 - 1975	:	Taper washers for I-Beams (ISMB).

IS 6610 - 1972	:	Heavy washers for steel structures.
IS 6623 - 2004	:	High strength structural nuts.
IS 6639 - 1972	:	Hexagonal bolts for steel structures.
IS 6649 - 1985	:	Hardened and tempered washers for high strength Structural bolts and nuts.
IS 6745 - 1972	:	Methods of determination of mass of zinc coating on zinc coated iron and steel articles.
IS 7215 - 1974	:	Tolerances for fabrication of steel structures.
IS 7310 (Part 1) - 1974	:	Approval tests for welders working to approved welding procedures – Part 1 – Fusion welding of steel.
IS 7318 (Part 1) & (Part 2) - 1974	:	Approval tests for welders when welding procedure approval is not required.
IS 8172 - 1976	:	Vertical steel ladder.
IS 8500 - 1991	:	Structural Steel – Micro alloyed (medium and high strength quality).
IS 9595 - 1996	:	Metal – Arc welding of carbon and carbon manganese steels – Recommendations.

9.2.1 This specification covers the fabrication and transportation to site and erection on prepared foundations and structural steel work consisting of beams, columns, vertical trusses, bracings, shear connections etc.

9.2.2 Fabrication, erection and approval of steel structures shall be in compliance with :

- These General Specifications and IS : 800 - 1984
- Drawings and supplementary drawings to be supplied to the contractors during execution of the work.

9.2.3 Providing shop primer coat for steel structures. Grouting of holding-down bolt pockets and below base plates where required.

9.2.4 In case of conflict between the Clauses mentioned here and the Indian Standards, those expressed in this specification shall govern.

9.3 Fabrication Drawings

9.3.1 The contractor shall prepare all fabrication and erection drawings on the basis of design drawings supplied to him and submit the same in triplicate to the Project Manager for review, Project Manager shall review and comment, if any, on the same. Such review, if any, by the Project Manager, does not relieve the contractor of any of his required guarantees responsibilities. The contractor shall however be responsible to fabricate the structurals strictly conforming to specifications and reviewed drawings.

9.3.2 Fabrication drawings shall include the following :

- Member sizes and details
- Types and dimensions of welds and bolts
- Shapes and sizes of edge preparation for welding
- Details of shop and field joints included in assemblies.

Bill of material

- Quality of structural steels, welding electrodes, bolts, nuts and washers etc. to be used.

- Erection assemblies, identifying all transportable parts and sub-assemblies, associated with special erection instructions, if required.

- Calculations where asked for, for approval.

9.3.3 Connections, splices etc. other details not specifically detailed in design drawings shall be suitably given on fabrication drawings considering normal detailing practices and developing full member strengths. Where asked for calculations for the merit shall also be submitted for approval.

9.3.4 Any alternate design or change in section is allowed when approved in writing by the Project Manager.

9.3.5 However if any variation in the scheme is found necessary later, the contractor will be supplied with revised drawings. The contractor shall incorporate these changes in his drawings at no extra cost and resubmit for review.

9.3.6 Project Manager review shall not absolve the contractor of his responsibility for the correctness of dimensions, adequacy of details and connections. One copy will be returned reviewed with or without comments to the contractor for necessary action. In the former case further three copies of amended drawings shall be submitted by the contractor for final review.

9.3.7 The contractor shall supply three prints each of the final reviewed drawings to the Project Manager within a week since final review, at no extra cost for reference and records.

9.3.8 The Project Manager will verify the correct interpretation of their requirements.

9.3.9 If any modification is made in the design drawing during the course of execution of the job, revised design drawings will be issued to the contractor. Further changes arising out of these shall be incorporated by the contractor in the fabrication drawings already prepared at no extra cost and the revised fabrication drawings shall be duly got reviewed as per the above Clauses.

Review of fabrication drawings by Engineer-In-Charge shall in no way relieve the CONTRACTOR of his responsibility of correctness of Engineering and execution of the work.

CONTRACTOR shall be required to modify / rectify the structure at any stage of the work in case Engineer-In-Charge brings to his attention any mistake / omission in the fabrication drawings and the fabrication based on these drawings.

All such modifications / rectifications shall be made by the CONTRACTOR at no extra cost to ITC.

Fabrication and erection drawings shall be thoroughly checked, stamped “Approved for Construction” and signed by the CONTRACTOR’s authorized representative, to ensure accuracy and correctness of the drawings.
Unchecked and unsigned drawings shall be rejected and treated as non-submission.

Review of fabrication drawings by Engineer-In-Charge shall be limited to the layout, arrangement, sizes of members and connection between members.
All other details shown on the fabrication drawings shall be the responsibility of the CONTRACTOR.

The CONTRACTOR shall ensure accuracy of the following, (but not limited to) and shall be solely responsible for the same:

(a) Provision for erection and erection clearances.

(b) Marking of members.

(c) Cut length of members.

(d) Matching of joint and holes

(e) Provision kept in the members for other interconnected members.

(f) Bill of materials.

Fabrication drawings drawn to a proper scale and large enough to convey the information clearly and adequately shall include the following but not limited to:

- Reference to design drawing number (along with revision number), based on which fabrication drawing has been prepared.

- Structural layout, elevation and sections. These shall contain distinct erection marking of all members.

- Framing plans member sizes, orientation and elevations.

- Layout, detailing of rain water pipes and gutters showing all necessary levels and connections wherever required.

- Detailing of shop/field joints, connections, splices, for required strength and erection.

- Location, type, size and dimensions of welds and bolts.

- Shapes and sizes of edge preparation for welding.

- Details of shop and field joints / welds.
- Bill of materials.

- Quality of structural steel, plates, welding electrodes, bolts, nuts, washers etc to be used.

- Erection assemblies identifying all transportable parts and sub-assemblies with special erection instructions, if required.

- Method of erection and special precautions to be taken during erection as required.

Connections, splices and other details, where not shown on the design drawings shall be suitably designed and shown on the fabrication drawings based on Standard Engineering Practice developing full member strength. Design calculation of such connections shall be submitted by CONTRACTOR and approved by TEIL.

Any substitution or change in section shall be allowed only when prior written approval of the Engineer-In-Charge has been obtained. Fabrication drawings shall be updated incorporating all such substitutions / changes by the CONTRACTOR at no extra cost.

In case during execution of the work, the Engineer-In-Charge considers any modifications / substitutions necessary, the CONTRACTOR shall incorporate the same in the drawings without any extra cost. The CONTRACTOR shall however be totally responsible for the correctness of the detailed fabrication drawings and execution of the work.

CONTRACTOR shall incorporate all the revisions made in the design drawings, during the course of execution of work in his fabrication drawings, and resubmit the drawings at no extra cost.

Preparation of Fabrication Drawings shall be in AUTOCAD 13 only. Submission of Fabrication Drawings in Electronic form shall be as per the instructions of Engineer-In-Charge. Fabrication drawings shall be prepared in A1 size only.

Unless stated otherwise, submission procedure shall be as stated below.
Initially CONTRACTOR shall submit 3 copies of all fabrication and erection drawings for review by Engineer-In-Charge.
Engineer-In-Charge shall return 1 copy of CONTRACTOR' s drawings marked with his approval and/or comments.
CONTRACTOR shall submit to Engineer-In-Charge with 6 copies of all approved and final drawings for field use and record purposes.
CONTRACTOR shall submit 2 copies of all the As-Built drawings to Engineer-In-Charge for reference and record.

9.4 Materials

9.4.1 Rolled Sections

The following grades of steel shall be used for steel structures :

Structural steel will generally be of standard quality conforming to IS: 226. Whenever welded construction is specified plates of more than 20 mm thickness will generally conform to IS: 2062.

9.4.2 Welding Materials

Welding electrodes shall conform to IS: 814.

Approval of welding procedures shall be as per IS: 823.

9.4.3 Bolts, Nuts & Washers

Bolts and nuts shall be as per IS: 1367 and tested as per IS:1608. It shall have a minimum tensile strength of 44 Kg/mm2 and minimum elongation of 23% on a gauge length of 5.65 (A- Original cross sectional area of the gauge length). Washers shall be as per IS: 2016.

9.4.4 All materials shall conform to their respective specifications. The use of equivalent or higher grade or alternate materials will be considered only in very special cases subject to the approval of the Project Manager in writing.

9.4.5 Receipt & Storing of Materials

Steel materials supplied by the contractor must be marked for identification and each lot should be accompanied by manufacturer's quality certificate, conforming chemical analysis and mechanical characteristics.
All steel parts furnished by supplier shall be checked, sorted out, straightened, and arranged by grades and qualities in stores.

Structurals with surface defects such as pitting, cracks, laminations etc. shall be rejected if the defects exceed the allowable tolerances specified in relevant standards or as directed by the Project Manager.

Welding wire and electrodes shall be stored separately by qualities and lots inside a dry and enclosed room, in compliance with IS: 816 - 1969 and as per instructions given by the Project Manager. Electrodes shall be perfectly dry and drawn from an electrode even, if required.

Checking of quality bolts of any kind as well as storage of same shall be made conforming to relevant standards.

Each lot of electrodes, bolts, nuts, etc. shall be accompanied by manufacturer's test certificate.

The contractor may use alternative materials as compared to design specification only with the written approval of the Project Manager.

9.4.6 Material Tests

The contractor shall be required to produce manufacturer's quality certificates for the materials supplied by the contractor. Notwithstanding the manufacturer's certificates, the Project Manager may ask for testing of materials in approved test houses. The test results shall satisfy the requirements of the relevant Indian Standards.

Whenever quality certificates are missing or incomplete or when material quality differs from standard specifications the contractor shall conduct all appropriate tests as directed by the Project Manager at no extra cost.

Materials for which test certificates are not available or for which test results do not tally with relevant standard specifications, shall not be used.

9.5 Fabrication

Fabrication shall be in accordance with IS: 800 Section V in addition to the following :

Fabrication shall be done as per approved fabrication drawings adhering strictly to work points and work lines on the same. The connections shall be welded or bolted as per design drawings. Work shall also include fabricating built up sections.

Any defective material used shall be replaced by the contractor at his own expense, care being taken to prevent any damage to the structure during removal.

All the fabricated and delivered items shall be suitably packed to be protected from any damage during transportation and handling. Any damage caused at any time shall be made good by the Contractor at his own cost.

Any faulty fabrication pointed out at any stage of work shall be made good by the contractor at his own cost.

9.5.1 Preparation of Materials

Prior to release for fabrication, all rolled sections warped beyond allowable limit shall be pressed or rolled straight and freed from twists, taking care that an uniform pressure is applied.

Minor warping, corrugations etc. in rolled sections shall be rectified by cold working.
The sections shall be straightened by hot working where the Project Manager so direct and shall cooled slowly after straightening.

Warped members like plates and flats may be used as such only if wave like deformation does not exceed L/1000 but limited to 10 mm (L-Length).

Surface of members that are to be jointed by lap or fillet welding or bolting shall be even so that there is no gap between overlapping surfaces.

9.5.2 Marking

Marking of members shall be made on horizontal pads, of an appropriate racks or supports in order to ensure horizontal and straight placement of such members.
Marking accuracy shall be atleast + 1 mm.

9.5.3 Cutting

Members shall be cut mechanically (by saw or shear or by oxyacetylene flame).

All sharp, rough, or broken edges, and all edges of joints which are subjected to tensile or oscillating stresses, shall be ground.

No electric metal arc cutting shall be allowed.

All edges cut by oxyacetylene process shall be cleaned of impurities prior to assembly.

Cutting tolerances shall be as follows :

a) For members connected at both ends + 1 mm.
b) Elsewhere + 3 mm.

The edge preparation for welding of members more than 12 mm thick shall be done by flame cutting and grinding. Cut faces shall not have cracks or be rough.

Edge preparation shall be as per IS : 823 - 1964.

9.5.4 Drilling

Bolts holes shall be drilled.

Drilling shall be made to the diameter specified in drawings.

No enlarging of holes filling, by mandrolling or oxyacetylene flame shall be allowed.

Allowed variations for holes (out-of-roundness, eccentricity, plumb-line deviation) shall be as per IS:800.

- Maximum deviation for spacing of two holes on the same axis shall be + 1 mm.

- Two perpendicular diameters of any oval hole shall not differ by more than 1 mm.

Drilling faults in holes may be rectified by reaming the holes to the next upper diameter, provided that spacing of new hole centres and distance of hole centres to the edges of members are not less than allowed and that the increase of hole diameter does not impair the structural strength. Hole reaming shall be allowed if the number of faulty holes does not exceed 15% of the total number of holes for one joint.

9.5.6 Preparation of Members for Welding

Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, axes nodes etc.)

Sharp edges, rust of cut edges, notches, irregularities and fissures due to faulty cutting shall be chipped or ground or filled over the length of the affected area, deep enough to remove faults completely.

Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint.

Generally no special edge preparation shall be required for members under 8 mm thick.

Edge preparation (bevelling) denotes cutting of the same so as to result in V, X K or U seam shapes as per IS: 823.

The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy, rust or dirt covered parts be assembled. Joints shall be kept free from any foreign matter likely to get in to the gaps between members to be welded.

Before assembly the edges to be welded as well as adjacent areas extending for atleast 20 mm shall be cleaned (until metallic polish is achieved).

When assembling members, proper care shall be taken of welding shrinkage and distortions, as the drawing dimensions cover finished dimensions of the structure.

The elements shall be got checked and approved by the Project Manager or their authorised representative before assembly.

The permissible tolerances for assembly of members preparatory to welding shall be as per IS: 823-1964.

After the assemble has been checked, temporary tack welding in position shall be done by electric welding, keeping in view finished dimensions of the structure.

9.5.7 Welding procedures

Welding shall be carried out only by fully trained and experienced welders as tested and approved by the Project Manager. Any test carried out either by the Project Manager of their representative or the inspectors shall constitute a right by them for such tests and the cost involved thereon shall be borne by the contractor himself.

Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS: 823. The nature of test for performance qualification of welders shall be commensurate with the quality of welding required on this job as judged by the Project Manager.

The steel structures shall be automatically, semi-automatically or manually welded.

Welding shall begin only after the checks mentioned in Clause 5.1 to 5.6 have been carried out.

The welder shall mark with his identification mark on each element welded by him. When welding is carried out in open air, steps shall be taken to protect the face of welding against wind or rain. The electrodes, wire and parts being welded shall be dry.

Before beginning the welding operation, each joint shall be checked to ensure that the parts to be welded are clean and root gaps provided as per IS: 823.

For continuing the welding of seems discontinued due to some reason, the end of the discontinued seem shall be melted in order to obtain a good continuity. Before resuming the welding operation, the groove as well as the adjacent parts shall be well cleaned for a length of approx. 50 mm.

For single butt welds (in V, 1/2 V or U) and double butt welds (in K, double U etc.) the rewelding of the root is mandatory but only the metal deposit on the root has been cleaned by back gouging or chipping.

The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any other method.

For multi-layer welding, before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing. Backing strips shall not be allowed.

The order and method of welding shall be so that -

- No unacceptable deformation appears in the welded parts.

- Due margin is provided to compensate for contraction due to welding in order to avoid any high permanent stresses.

The defects in welds must be rectified according to IS: 823 and as per instruction of Project Manager.

9.5.8 Weld Inspection

The weld seams shall satisfy the following :

- shall correspond to design shapes and dimensions.

- shall not have any defects such as cracks, incomplete penetration and fusion, under-cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible limits.

During the welding operation and approval of finished elements, inspections and tests shall be made as shown in annexure-B.

The mechanical characteristics of the welded joints shall be as in IS: 823.

9.5.9 Preparation of Members for Bolting

The members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation and bending.

Before assembly, all sharp edges, shavings, rust dirt, etc. shall be removed.

Before assembly, the contacting surfaces of the members shall be cleaned and given a coat of primer as per IS: 2074.

The members which are bolt assembled shall be set according to drawings and temporarily fastened with erection bolts (minimum 4 pieces) to check the coaxiality of the holes.

The members shall be finally bolted after the deviations have been corrected, after which there shall not be gaps.

Before assembly, the members shall be checked and got approved by the Project Manager.

The difference in thickness of the sections that are butt assembled shall not be more than 3% or maximum 0.8 mm whichever is less. If the difference is larger, it shall be corrected by grinding or filling.

Reaming of holes to final diameter or cleaning of these shall be done only after the parts have been check assembled.

As each hole is finished to final dimensions (reamed if necessary) it shall be set and bolted up. Erection bolts shall not be removed before other bolts are set.

9.5.10 Bolting up

Final bolting of the members shall be done after the defects have been rectified and approval of joints obtained.

The bolts shall be tightened starting from the centre of joint towards the edge.

9.5.11 Planing of Ends

Planing of ends of members like column ends shall be done by grinding when so specified in the design.

Planing of butt welded members shall be done after these have been assembled, the spare edges shall be removed with grinding machines or files.

The following tolerances shall be permitted on member that have been planed.

- On the length of the member having both ends planed, maximum + 2 mm with respect to design.

- Level differences of planed surfaces, maximum 0.3 mm.

- Deviation between planed surface and member's axis maximum 1/1500.

9.5.12 Holes for Field Joints

Holes for field joints shall be drilled in the shop to final diameters and tested in the shop, with trial assemblies.

When three-dimensional assembly is not possible in the shop, the holes for field joints may be drilled in shop and reamed on site after erection, on approval by the Project Manager.

For bolted steel structures, trial assembly in shop is mandatory.

The tolerance for spacing of holes shall be + 1 mm.

9.5.13 Tolerances

All tolerances regarding dimensions, geometrical shapes and sections of steel structures, shall be as per Annexure B, if not specified in the drawing.

9.5.14 Marking for Identification

All elements and members prior to despatch for erection shall be shop marked.

The members shall be visibly marked with a weather proof light coloured paint. The size and thickness of the numbers shall be chosen as to facilitate the indentification of members.

For the small members that are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle, while the crates shall be marked directly.

Each bundle or crate shall be packed with members for one and the same assembly; in the same bundle or crate, general utility members such as bolts, quests etc. may be packed.

All bill of materials showing weight, quality and dimension of contents shall be placed in the crates.

The members shall be marked with a durable paint, in a visible location, preferably at one end of the member so that these may be easily checked during storage and erection.

All members shall be marked in the shop before inspection and acceptance.

When the member is being painted, the marking area shall not be painted but bordered with white paint.

The marking and job symbol shall be registered in all shop delivery documents (transportation, for erection etc.)

9.5.15 Shop Test Pre-assembly

For steel structures that have the same type of welding the shop test pre-assembly shall be performed on one out of every 10 members minimum.

For bolted steel structures, shop test pre-assembly is mandatory for all elements as well as for the entire structure in conformity with Clause 5.12.

9.6 Shop Inspection and Approval

9.6.1 General

The Project Manager or their representative shall have free access at all responsible times to the contractors fabrication shop and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with drawings and specifications.

Technical approval of the steel structure in the shop by the Project Manager is mandatory.

The contractor shall not limit the number and kinds of tests, final as well as intermediate once, or extra tests required by the Project Manager.

The contractor shall furnish necessary tools, gauges, instruments etc. and technical non-technical personnel for shop tests by the Project Manager, free of cost.

9.6.2 Shop Acceptance

The Project Manager shall inspect and approve at the following stages :

The following approvals may given in shop :

- Intermediate approvals of work that cannot be inspected later.
- Partial approvals
- Final approvals

Intermediate approval of work shall be given when a part of the work is preformed later :

- Cannot be inspected later
- Inspection would be difficult to perform and results would not be satisfactory.

Partial approval in the shop is given on members and assemblies of steel structures before the primer coat is applied and includes :

- Approval of materials

- Approval of field joints
- Approval of parts with planed surfaces
- Test erection
- Approval of members
- Approval of markings
- Inspections and approvals of special features, like Rollers, loading platform mechanism etc.

During the partial approval, intermediate approvals as well as all former approvals, shall be taken in to consideration.

9.6.3 Final approval in the Shop

The final approval refers to all elements and assemblies of the steel structures, with shop primer coat, ready for delivery from shop to be loaded for transportation, or stored.

The final approval comprises of :

- Partial approvals
- Approval of shop primer coat
- Approval of mode of loading and transport
- Approval of storage (for materials stored)

9.7 Painting and Delivery

9.7.1 Preparation of parts for shop painting

Painting shall consist of providing one coat of red oxide zinc chromate primer to steel members before despatch from shop.

Primer coat shall not be applied unless :

- Surface have been wire brushed, cleaned of dust, oil, rust etc.

- Erection gaps between members, spots that cannot be painted or where moisture or other aggressive agents may penetrate, have been filled with an approved type of oil and putty.

- The surface to be painted are completely dry.

- The parts where water of aggressive agents may collect (during transportation, storage, erection and operation) are filled with putty and provided with holes for drainage of water.

- Members and parts have been inspected and accepted

- Welds have been accepted.

The following are not to be painted or protected by any other product :

- Surface which are in the vicinity of joints to be welded at site.

- Surfaces bearing markings

- Other surfaces indicated in the design.

The following shall be given a coat of hot oil or any approved resistant lubricant only.

- Planed surfaces
- Holes for links

The surfaces that are to be embedded or in contact with the concrete shall be given a cost of cement wash.

The surfaces which are in contact with the ground, gravel or brick work and subject to moisture, shall be given bituminous coat.

The other surfaces shall be given a primer coating.

Special attention shall be given to locations not easily accessible, where water can collect and which after assembly and erection cannot be inspected, painted and maintained. Holes shall be provided for water drainage and in accessible box type sections shall be hermetically sealed by welds.

If specified elsewhere, in the schedule of quantities, the contractor shall paint further coats of red-oxide after erection and placing in position of the steel structures.

9.7.2 Packing, transportation, delivery

After final shop acceptance and marking, the item shall be packed and loaded for transportation.

Packing must be adequate to protect item against warping during loading and unloading.

Proper lifting devices shall be used for loading, in order to protect items against warping.

Slender projecting parts shall be braced with additional steel bars, before loading, for protection against warping during transportation.

Loading and transportation shall be done in compliance with transportation rules.

If certain parts cannot be transported in the lengths stipulated in the design, the position and type of additional splice joints shall be approved by the Project Manager.

Items must be carefully loaded on platforms of transportation means to prevent warping, bending or falling during transportation.

The small parts such as fish-plates, quests etc. shall be securely tied with wire to their respective parts.

Bolts, nuts and washers shall be packed and transported in crates.

The parts shall be delivered in the order stipulated by the Project Manager and shall be accompanied by document showing:

- Quality and quantity of structure or members
- Position of member in the structure
- Particulars of structure
- Identification number job symbol.

9.8 Field Erection

9.8.1 The erection work shall be permitted only after the foundation or other structure over which the steel work will be erected is approved and is ready for erection.

9.8.2 The contractor shall satisfy himself about the levels, alignment etc. for the foundations well in advance, before starting the erection. Minor chipping etc. shall be carried out by the contractor on his expense.

9.8.3 Any faulty erection done by the contractor shall be made good at his own cost.

9.8.4 Approval by the Project Manager or their representatives at any stage of work does not relieve the contractor of any of his required guarantees of the contract.

9.8.5 Storage and preparation of parts prior to erection

The storage place for steel parts shall be prepared in advance and got approved by the Project Manager before the steel structures start arriving from the shop.

A platform shall be provided by the Contractor near the erection site for preliminary erection work.

The contractor shall make the following verifications upon receipt of material at site.

- for quality certificates regarding materials and workmanship according to these general specifications and drawings.
- Whether parts received are complete without defects due to transportation, loading and unloading and defects, if any, are well within the admissible limit.

For the above work sufficient space must be allotted in the storage area.

Steps shall be taken to prevent warping of items during unloading.

The parts shall be unloaded, stored and stored so as to be easily identified.

The parts shall be stored according to construction symbol and markings so that these may be taken out in order or erection.

The parts shall be at least 150 mm clear from ground on wooden or steel blocks for protection against direct contact with ground and to permit drainage of water.

If rectification of members like straightening etc. are required, these shall be done in a special place allotted which shall be adequately equipped.

The parts shall be clean when delivered for erection.

9.8.6 Erection & Tolerances

Erection in general shall be carried out as required and approved by the Project Manager.

Positioning and levelling of the structure, alignment and plumbing of the stanchion and fixing every member of the structure shall be in accordance with the relevant drawings and to the complete satisfaction of the Project Manager.

The following checks and inspection shall be carried out before during and after erection.

- damage during transportation
- accuracy of alignment of structures
- erection according to drawings and specifications
- progress and workmanship.

In case there be any deviations regarding positions of foundations or anchor bolts, which would lead to erection deviations, the Project Manager shall be informed immediately. Minor rectifications in foundations, orientation of bolts holes etc. shall be carried out as part of the work, at no extra cost.

The various parts of the steel structure shall be so erected so to ensure stability against inherent weight, wind and erection stresses.

The structure shall be anchored and final erection joints completed after plan and elevation positions of the structural members have been verified with corresponding drawings and approved by the Project Manager.

The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the member. For parts with sloping surfaces tapered washers shall be used.

9.9 Final acceptance and handing over the structure

9.9.1 At acceptance, the contractor shall submit the following documents :

- Shop and erection drawings - either in tracings or reproducible.

- 4 copies of each of the following :

  \- shop acceptance documents
  \- quality certificate for structurals, plates, etc. (electrodes, welding wire, bolts, nuts, washers etc.)
  \- List of certified welders who worked on erection of structures.
  \- acceptance and intermediate control procedure of erection operations.

9.9.2 Approval by the Project Manager at any stage of work does not relieve the contractor of any of his required guarantees of the contract.

9.10 Method of Payments

9.10.1 Payment for steel work shall be made on basis of admissible weight of the structure accepted, the weight being determined as described in such Clause 9.10.2 below :

The rate for supply, fabrication and erection, shall include cost of all handling and transportation to Owner's store/site o work where supply and fabrication only are involved, trimming, straightening, edge preparation, preparation and getting reviewed of fabrication drawings, and providing one or more coat of Red-oxide zinc chromate primer as specified in the schedule of quantity.

In the case, Owner supplies materials the rate shall include cost of steel materials taking delivery of the materials, from owner's store all handling and rehandling, loading and unloading, transport to site or work, returning of surplus materials to owner's stores etc. complete as well as the cost of all handling and transport,

scaffolding, temporary supports, tools and tackles, touching up primer coat, grouting etc.

9.10.2 The actual lengths installed shall be measured and the weight of structural material/plate shall be calculated wherever necessary on the basis of IS handbook. If sections are different from IS section, then manufacturers handbook shall be adopted. No allowance in weights shall be made for rolling tolerance.

9.10.3 Sections built out of plates, structural shall be paid on the actual weight incorporated except for gussets which will be paid on the weight of the smallest rectangle enclosing the shape. No deductions shall be made for skew cuts in rolled steel sections.

9.10.4 Welds, bolts, nuts, washers, etc. shall not be measured. Rate for structural steel work shall be deemed to include the same.

9.10.5 No other payment either for temporary works connected with this contract or for any other item such as welds, shims, pacing plates etc. shall be made. Such item shall be deemed to have been allowed for in the rate quoted for steel work.

9.11 Grouting of Pockets

9.11.1 Grouting of pockets and under base plates will be done only after the steel work has been levelled and plumbed and the bases of stranchions are supported by steel shims. The space below the base plate and pockets shall be thoroughly cleaned.

9.11.2 The mortar used for grouting shall not be leaner than 1:2 (1 cement : 2 sand) (grade 300 in case of concrete) and shall be mixed to the minimum consistency required. It shall be poured under suitable head and tamped until the space has been completely filled.

9.12 Tolerances allowed in the erection of plant building without cranes

The maximum tolerances for line and level of the steel work shall be + 3.00 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10 M. 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.

9.13 <u>ANCHOR BOLTS</u>

9.13.1 <u>Material</u>

(a) Anchor bolts shall be turned from plain and mild conforming to IS 432 grade 1.

(b) Nuts and lock nuts (hexagonal type) shall be of grade “B” as per IS 1367 and conform to IS 1363.

(c) Washers shall be of mild steel conforming to IS 2016.

(d) Pipe sleeves shall be of mild steel tubes (medium duty) conforming to IS 1239.

(e) Anchor plates and ribs shall conform to IS 2062.

9.13.2 Fabrication

Fabrication of anchor bolts and their complete assemblies shall be strictly in compliance with the specifications and drawings. Anchor bolts shall have coarse type threads conforming to IS 4218.

9.13.3 Placement

Anchor bolts assemblies shall be placed in position strictly as per drawings and securely held during pouring and vibrating of concrete with necessary templates and other dummy structures to prevent their dislocation.

9.13.4 Tolerances

Tolerances allowed for anchor bolts positioning shall be:
- For sleeved bolts, one tenth of the bolt nominal diameter.

- For bolts without sleeves, one twentieth of the bolt nominal diameter.

9.13.5 Protection

The exposed surfaces of bolts shall be properly covered (after greasing of bolts and packing of sleeves) with jute cloth so as to protect them from damage.

9.14 M.S. INSERTS / CORNER ANGLES

9.14.1 Material

(a) MS inserts / corner angles shall be of mild steel conforming to IS 2062.

(b) Lugs shall be of mild steel bars conforming to IS 432 Grade 1.

9.14.2 Fabrication

Fabrication of inserts / corner angles shall be done strictly as per drawings and in compliance with the requirements given in specification.

9.14.3 Placement

MS inserts / corner angles shall be correctly embedded as per their location shown in the drawings. Care shall be taken that these are securely held in position and do not get disturbed during concreting. Where necessary, these may be welded to the reinforcement bars. Suitable templates, spacers, dummy structures and temporary staging shall be provided. Necessary cutting in the form work and adjustment of reinforcement bars shall be affected for the placement of inserts / corner angles where required.

9.15 CHEQUERED PLATES

9.15.1 Material

The material shall conform to IS 2062.

9.15.2 Fabrication

Chequered plate shall be fabricated as per the "Approved for Construction" fabrication drawings (prepared by the CONTRACTOR based on design drawings). These shall be perfectly flat and without any dents / deformations and shall be cut to the required size and shape. Holes / notches / openings of the required size shall be provided as per the drawings.

Nosing for staircase treads shall be made by cold bending of chequered plates. All edges shall be made smooth and even. All chequered plate units shall be given distinct erection marks in accordance with the marking drawings.

9.15.3 Erection / Fixing

Chequered plates shall be fixed to the bearing members by welding / bolting as shown in the drawings.

9.16 HAND RAILING

9.16.1 Material

a) Tubes for hand railing shall be 32mm nominal diameter of mild steel medium grade conforming to IS 1239.

b) Toe plates and mid plates shall be of mild steel conforming to IS 2062.

c) Posts shall be of mild steel angle conforming to IS 2062.

9.16.2 Fabrication

Hand railing shall be fabricated strictly as per the "Approved for Construction" fabrication drawings prepared by the CONTRACTOR based on design drawings and standards. All tubes shall be straight and without any dents / deformations. Tubes shall be cut and ends shall be prepared to a neat and workman like finish. All elements shall be directly welded. Tubes shall be cold bent to shape and curvature in case of discontinuous ends of handrails. Lower ends of vertical posts shall be cut and splayed (for grouting in pockets provided in the concrete members). For removable type of hand railing, suitable base plates (with provision for bolting) shall be welded to the lower end of vertical posts. Chequered plates and gratings shall be suitably notched to accommodate vertical posts / their base plates wherever required. All units shall be given distinct erection marks in accordance with the marking drawings.

9.16.3 Erection / Fixing

Hand railing shall be fixed to the bearing members by welding / bolting / grouting as indicated in the drawings.

9.17 **Rolling Shutters**

Rolling shutters shall be in extruded MS sections, of approved make, type and finish. These shutters shall be complete with locking arrangements, hoods, guides, pulling devices, springs and other accessories. Wherever specified, mechanical device shall be fixed for easy operation of the shutters.

10.0 ROAD WORKS

10.1 Scope

This specification deals with general specifications of roadwork and also excavation for road work, preparation of sub-grade, sub-base, base and surface courses.

10.1.1 Quality Control

For check on quality of Road item, refer IRC special publication 11 "Hand book of Quality Control for Construction of Roads and Runways".

10.2 Earth work

10.2.1 Site Clearance

Site clearance shall be as specified and directed by the Project Manager.

10.2.2 Setting out and making profile

Masonry pillars shall be erected at suitable points in the area which is visible from the largest area to serve as bench mark, for the excavation of the work. Necessary profiles with pegs, bamboos and strings or 'Burjis' shall be made to show the correct formation levels before the work is started.

Ground levels shall be taken at 5 to 15 metres intervals (or as directed by the Architect/Project Manager) in uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with. The ground levels shall be recorded in field books and plotted on plans. The plans shall be drawn to a suitable scale as decided by the Architect/Project Manager. These plans shall be signed by the Contractor and the Architect/ Project Manager or his representative before earth work is started. Labour and instruments required for taking levels shall be supplied by the contractor at his own cost and also shall bear the cost of making pillars for bench marks.

10.2.3 Measurements

10.2.3.1 The length, breadth and depth shall be measured correct to a cm. in case the measurements are taken with tape. If the measurements are taken with staff and level, the level shall be recorded correct to 5 mm and depth of cutting and heights of filling calculated correct to 5 mm. The cubical contents shall be worked out to the nearest two places of decimal, in cubic meter.

10.2.3.2 Where excavation is in fairly uniform ground, the measurements of cutting in trenches or barrow pits shall be made.

10.2.3.3 Where the ground is not fairly uniform or where the site is required to be levelled, levels shall be taken before the start and after the completion of the work and the quantity of excavation in cutting computed from these levels.

10.2.3.4 Where it is not possible or convenient to take measurements from barrow pits or cutting, excavation shall be worked out from filling. The actual measurements of the fill shall be calculated by taking levels, of the original ground before start of the work after site clearance and after compaction of the fill at suitable intervals and the quantity of earth work so computed shall be reduced by 10% in case of consolidation fills, 5% in case the consolidation is done by heavy mechanical machinery to arrive at net cubical contents. No such deduction shall, however, be done in case of:

i) Consolidation done by heavy machinery at optimum moisture contents

ii) Consolidated fillings in confined situation such as under floors.

10.3 Sub-grade

10.3.1 Preparation of sub-grade

The surface of the formation for a width of sub base, which shall be 15 cm. more on either side of base course, shall first be cut to a depth equal to the combined depth of such base (stone soling), base and surface courses below the proposed finished level. It shall be cleaned of all foreign substances and sub grade dressed off parallel to the finished profile and compacted and surface got approved from the Architect/Project Manager. The density to be achieved shall not be less than 95% of the density obtained in the laboratory (Proctor Method).

10.4 Sub-base

10.4.1 With Stone soling

The size of stone should not be more than 22.5 cm nor less than 10 cm. in any direction, and height equal to the soling course with tolerance of 25 mm. After the preparation of sub grade, stone soling shall be laid. Care shall be taken that stones are laid on edges and packing with small stones shall be done as soling work proceeds blinding material shall then be spread and consolidation done with power roller (8 - 10 Tons). Irregularities in surface shall be corrected as consolidation proceeds. Rate shall include the cost of all materials and labour required for all operations mentioned above.

10.4.2 Water bound macadam

Water bound macadam with stone aggregate 90 mm to 40 mm size. This consists of clean crushed coarse aggregate mechanically interlocked by rolling, and voids thereof filled with screening and binding material with the assistance of water, laid on a prepared subgrade, sub base or the case may be coarse aggregate.

10.4.2.1 Quantities of materials

Quantities of coarse aggregate screening and binding material required to be stacked for 100 mm approximate compacted thickness of WBM sub base coarse for 10 Sq.m shall be as per Table 10.1 below:

TABLE - 10.1

Coarse Aggregate	**Stone screening**	**Binding material**
Classfication Size Loose Qty	Grading/Classification and loose qty	
Grading-I 90mm to 40mm 1.3 Sqm	Type 12.5mm 0.42 Sqm	0.10 Cum

10.4.2.2 The water bound macadam sub-base shall be normally constructed in layers of 100 mm compacted thickness. 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.

10.5 Base

10.5.1 WBM: Same as item 10.4.2 except size of coarse aggregate, which shall be 63 mm to 40 mm size in this case.

10.5.1.1 **Quantities of materials**

Quantities of coarse aggregate and screening required for 75mm approximate compacted thickness of WBM base coarse for 10 Sqm. shall be as specified below in Table - 10.2.

TABLE - 10.2

Coarse aggregate	**Stone Screening**
Classification Size range Loose Qty.	Grading/Classification & Size Loose Qty
Grading-2 63 - 40mm 1.0 Cum	Type-A 12.50mm 0.20 Cum
Grading-2 63 – 40mm 1.0 Cum	Type-B 10.00mm 0.30 Cum

The quantity of binding material required for 75 mm compacted thickness will be 0.09 Cum/10 Sqm. in case of WBM base coarse and 0.13 Cum/10 Sqm. when WBM is to function as surface coarse.

10.5.2 **Spreading Aggregate**

The coarse aggregate shall be spread uniformly and evenly upon the prepared base in required quantities with a twisting motion to avoid segregation. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base be permitted. The aggregates shall be spread uniformly to proper profile by using templates placed across the road six metres apart. The levels along the longitudinal direction up to which the metal shall be laid, shall be first obtained at site to the satisfaction of the Project Manager and these shall be adhered to.

The surface of the aggregate spread shall be carefully trued up and all high or low spots remedied by removing or adding aggregate as may be required.

The WBM sub-base shall be normally constructed in layers of 100 mm compacted thickness. 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.

10.5.3 **Rolling**

Immediately following the spreading of the coarse aggregate, it shall be compacted to the full width by rolling with either a three-wheel-power-roller of 8 to 10 tonnes capacity or an equivalent vibratory roller. Initially, light rolling is to be done, which shall be discontinued when the aggregate is partially compacted with sufficient void space in them to permit application of screenings.

The rolling shall begin from the edges with the roller running forward and backward and adding the screenings simultaneously until the edges have

been firmly compacted. The roller shall then progress gradually from the edges to the centre, parallel to the centre line of the road and overlapping uniformly each preceding rear wheel track by one half width and shall continue until the entire area of the course has been rolled by the rear wheel. Rolling shall continue until the road metal is thoroughly keyed with no creeping of metal ahead of the roller. Only slight sprinkling of water may be done during rolling, if required. On superelevated curves, the rolling shall proceed from the lower edge and progress gradually continuing towards the upper edge of the pavement.

Rolling shall not be done when the sub grade is soft or yielding or when the rolling causes a wave like motion in the sub-base or sub-grade. When rolling develops irregularities that exceed 12 mm when tested with a three meter straight edge, the irregular surface shall be loosened and then aggregate added to or removed from it as required and the area rolled until it gives a uniform surface conforming to the desired cross-section and grade. The surface shall also be checked transversely by template for camber and any irregularities corrected in the manner described above. In no case shall the use of screenings to make up depressions be permitted.

10.5.3.1 **Test for finding if the consolidation has been fully done is** :

A piece of about 25 mm stone is put on the consolidated surface and roller passed over it, it will be driven in if the consolidation is incomplete. Or, a fully loaded bullock cart going over it makes no impression.

10.5.4 **Application of Screenings**

After the coarse aggregate has been lightly rolled to the required true surface, screenings shall be applied gradually over the surface to completely fill the interstices. Dry rolling shall be continued while the screenings are being spread so that the jarring effect of the roller causes them to settle in to the voids of the coarse aggregates. The screenings shall not be dumped in piles on the coarse aggregate but shall be spread uniformly in successive thin layers either by the spreading motion of the hand, shovels or a mechanical spreader.

The screenings shall be applied at a slow rate (in three or more applications) so as to ensure filling of all voids. Rolling and brooming shall continue with the spreading of the screenings. Either mechanical brooms or hand brooms or both may be used. In no case shall be screenings be applied, so fast and thick as to form cakes, ridges on the surface making the filling of voids difficult or to prevent the direct bearing of the roller on the coarse aggregates. The spreading, rolling and brooming of screenings shall be performed on sections which can be completed within one days' operation of the coarse aggregate. Damp and wet screenings shall not be used under any circumstances.

10.5.5 **Sprinkling and Grouting**

After spreading the screening and rolling the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to seep the wet screening in to the voids and to distribute them evenly. the sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessary until the coarse aggregates are well bonded and firmly set for the entire depth and until a grout has been formed of screening and water that will fill all voids and form a wave of grout ahead of the wheels of the roller. The quantity of water to be used during the construction shall not be excessive so as to cause damage to the sub-base or sub-grade.

10.5.6 **Application of binding materials**

After the application of screenings and rolling, a suitable binding materials shall be applied at a uniform and slow rate in two or more successive thin layers. After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with hand brooms or mechanical brooms or both so as to fill the voids properly. The surface shall then be rolled by a 8 - 10 tonne roller, water being applied to the wheels in order to wash down the binding material that may get stuck to the wheels. The spreading of binding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry that is formed will, after filling the voids form a wave ahead of wheels of the moving roller.

10.5.7 **Setting and Drying**

After final compaction of the course, the road shall be allowed to cure overnight. Next morning defective spots shall be filled with screenings or binding material, lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed till the macadam sets.

10.5.8 **Surface evenness**

The surface evenness of completed WBM sub-base in the longitudinal and transverse directions shall be as specified below:

TABLE - 10.3

Size of coarse aggregate	**Longitudinal Profile**	**Cross Profile**
	Maximum permissible undulation when measured with a 3 Mtr. straight edge.	Maximum permissible undulation when measured with a camber template.
40 - 90mm	15mm	11mm

The longitudinal profile shall be checked with a 3 Mtr. long straight edge at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a series of three camber boards at intervals of 10 metres.

10.5.9 **Rectification of defective construction**

Where the surface irregularity of the WBM sub-base course exceeds the tolerances specified in Table 10.3 or where the course is otherwise defective due to sub-grade soil mixing with the aggregates, the layer to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable, and recompacted. The area treated in the aforesaid manner shall not be less than 10 Sqm. In no case shall depressions be filled up with screenings and binding materials.

10.5.10 **Measurements**

The length and breadth shall be taken to the nearest centimeter and thickness to the nearest half centimeter. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimals.

10.6 **Premix carpet with hot bitumen**

10.6.1 The treatment consists of applying a tack coat on the prepared base followed immediately by spreading aggregates precoated with specified binder to camber and consolidated. Premix carpet shall not be laid during rainy weather or when the atmospheric temperature in the shade is 16^0C or below.

10.6.2 **Aggregates**

The aggregates shall consist of angular fragments and the clean, hard, tough, demolish and of uniform quality throughout. They shall be crushed rock and should be free of elongated or flaky pieces, soft and disintegrated material, vegetable or other deleterious matter. The aggregate shall also satisfy the following properties:

TABLE - 10.4

S.No	Property	Value	Method of Test
1.	Abrasion value using los angles machine or aggregate impact value	Max. 35%	IS:2386(Part-IV)
2.	Flakiness index	Max. 30%	IS:2386(Part-I)
3.	Stripping value	Max. 25%	IS:6241
4.	Water absorption	Max. 2%	(Part-II

The aggregate shall be dry and heated to a temperature in the range of 155^0 - 163^0C. 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. At no time shall be difference in temperature between the aggregate and the binder exceeds 14^0C.

The mixing of binder with chipping shall be continued until the chipping are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use or suitable vehicles or wheel barrows. The vehicles employed for transport shall be clean and be covered over in transit if so directed. The temperature of mix at the time of laying shall be in the range of 121^0 - 163^0C.

10.6.3 **Quantities of materials**

Quantities of materials shall be as given in Table below. A proper record shall be kept to ensure daily out turn of work is co-related with the quantity of bitumen used.

TABLE - 10.5

Consolidated Thickness	Binder hot bitumen		Stone chipping	
	Tack coat (Kg./Sqm)	Carpet	Cum/100 Sq.m 12.5mm	10mm size
2.00 cm.	1.00	52 Kg./Cum of 12.5mm size and 56 Kg./Cum of 10mm size stone chipping	1.80	0.90
2.50 cm.	1.00	- Do-	2.25	1.12
4.00 cm.	1.00	- Do-	3.60	1.80

10.6.4 **Binder**

The binder shall be straight run bitumen of penetration grade 80/100 complying with IS: 73 - 1961.

10.6.5 **Preparation of surface and cleaning**

Prior to the application of the binder, all dust, dirt, caked mud, animal dung, loose and foreign material etc. shall be removed 30 cm. on either side, beyond the full width to be treated. For water bound macadam surface, the interstices between the road metal shall be exposed up to a depth of 10 mm by means of wire brushes. The surface shall then be brushed clean. The traces of fine dust shall be thoroughly removed from the surface by blowing air by air compressor.

10.6.6 **Applying tack coat**

The binder shall be heated in a boiler to a temperature shall be in the range of 160^0C - 177^0C and maintained at that temperature. The use of thermometer is essential.

The binder shall be applied evenly by means of pressure sprayer at the specified rate and longitudinally along the length of the road and across it. The edges of binder shall be defined by wire or rope. Excessive deposits of binder cause by stopping or stirring of sprayer or any other reason shall be suitable corrected.

10.6.7 **Preparation of premix**

The aggregate shall be dry and suitably heated to temperature as directed by Architect/Project Manager before these are placed in the mixer to facilitate mixing with the binder.

Mixers of approved type shall be employed for mixing the aggregate with the bituminous binder.

The binder shall be heated to the temperature in the range of 155^0 - 177^0C. in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

10.6.8 **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 9 tonne power rollers, preferably of smooth wheel tandem type, or other approved plant. Rolling shall begin at the edges and progress towards the centre longitudinally. Except on the super elevated portions rolling shall progress from the lower to upper edge, parallel to the centre line of the pavement. The consolidated thickness shall in no place be less than the specified thickness by more than 25%.

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 as it may get 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.

Further, the prepared finished surface shall be protected from traffic for 24 hours or such period as may be specified by the Architect/Project Manager.

10.6.9 **Surface finishing**

The surface regularity both in longitudinal and transverse directions shall be within the tolerances specified in Table below :

TABLE - 10.6

Max. permissible undulations to when measured with 3 M. straight edge.	Max. permissible variation from specified profile when measured with a camber template

The longitudinal profile shall be checked during rolling with a three metres long straight edge at the middle of each traffic lane along the road. Similarly the transverse profile shall be checked with a set of three camber boards at intervals of 10 metres.

10.6.10 **Rectification**

Where the surface irregularity falls outside the specified tolerances the contractor shall be liable to rectify it to the satisfaction of Project Manager by adding fresh material and recompacting to specifications where the surface is low. Where the surface is high the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

10.6.11 **Measurements**

The length and width of the finished work shall be measured correct to a cm. along the finished surface of the road. the area shall be calculated in square meter, correct to two places of decimal.

For record purposes, the measurement for binder and stone chipping shall be taken before they are actually used on the work. Pre-measurements of materials taken for record purposes shall simply serve as a guide and shall not from the basis for payment.

10.6.12 **Compaction test for carpet**

The degree of compaction achieved after rolling at sill shall be determined by taking out cores from finished surface at random places. Any other method approved by the Architect/Project Manager may also be used. The density of these field core samples shall be determined. For one field density test, a minimum of three samples for every 500 sqm. of compacted surface or less shall tested. The work shall be accepted as satisfactory and full payment shall be made if the average field density of every set of samples is not less than 98% of the laboratory density. In case of work yielding a density less than 98% but higher than 95% payment for the quality represented by the field density test shall be made at a reduced rate worked out in the proportion that the actual field density bears to the designed laboratory density.

In case the field density is less than 95% of the laboratory density, further rolling shall be done to improve the density. If the final density achieved is still less than 95% of the laboratory density, the work is liable to be rejected at the discretion of the Architect./Project Manager If such work is not rejected payment shall be made at such reduced rate as may be fixed by the Architect/Project Manager.

10.7 Concrete Pavements

10.7.1 Processing and Construction

10.7.1.1 Weather and Seasonal Limitations

Unless special precautions as specified are taken, concreting shall not be done during extreme weather conditions, e.g., during monsoon months, and when atmospheric temperature in shade is above 40^0C or below 4^0C. For guidelines for construction of cement concrete pavements in hot weather, reference may be made to IRC : 61-1976.

10.7.1.2 Preparation of base

The base to receive the cement concrete shall be checked for line, grade and cross-section as per the drawing. All irregularities beyond the permitted tolerances shall be rectified as specified.

Where concrete is to be laid over an absorbent surface, the latter shall be kept moist in saturated surface dry condition or covered over by a water-proof kraft/Polyethylene sheeting as specified so as to prevent absorption of water from the concrete mortar.

10.7.2 Fixing of formwork

The formwork shall be of correct shape, free from bends and kinks and sufficiently rigid to maintain its shape and position under the weight and working conditions of the laying and compacting equipment, It shall be set to true lines and levels and securely fixed in position to prevent any subsequent disturbance during compaction. Trueness of the formwork from the specified profile shall be checked and any deviation greater than 3mm in 3m rectified. No deviation shall, however, be permitted at the joints.

10.7.3 Manufacture and Placement of Concrete

Shall be carried out as specified in 'Concrete Work'.

10.7.3.1 Adequate surcharges of concrete shall be given over the desired finished level. The amount of surcharge shall be determined in the field by actual trial. The surcharge shall be uniform over the entire area and the concrete as spread shall be to the same camber and slope as the required finished surface.

10.7.3.2 The concrete shall be compacted fully using vibrating screeds and/or internal vibrators as specified. The vibrating screeds and internal vibrators shall conform to IS :2506 and IS:2505 respectively. Compaction shall be so controlled as to prevent excess mortar and water working on to the top due to over vibration.

10.7.3.3 During compaction, any low or high spots shall be made up by adding or removing concrete.

10.7.3.4 After longitudinal floating has been completed but while concrete is still plastic, the slab surface shall be tested for trueness with a 3m straight edge in accordance with the procedure set forth in the relevant clauses of CPWD specification 2000. Any depressions or high spots showing departure from the true surface shall be immediately rectified. High spots shall be cut down and refinished. Depressions shall be enlarged to about 8-10 cm and filled up with fresh concrete, compacted and finished. All the above operations shall be completed within 75 minutes/ (60 minutes in hot weather) of mixing.

10.7.3.5 After correcting the surface for profile but just before the concrete becomes non-plastic, the surface shall be finished by belting, brooming and edging as specified.

10.7.3.6 Where the slab is to be laid in two layers, the second layer shall be placed within 30 minutes of compaction of the lower layer.

10.7.4 **Control of Concrete Strength**

10.7.4.1 The strength of concrete shall be ascertained either from cube or beam specimens as specified. For this purpose, during the progress of work, cube/beam samples shall be cast for testing at 7 and 28 days. Sampling and testing shall be in accordance with IS : 1199 and 516 respectively. Frequency of testing shall be as indicated in Table.

TABLE

S.No.	TEST	TEST METHOD	MINIMUM DESIRABLE FREQUENCY
1.	Workability of fresh concrete	IS : 1199	One test per 10 m^3
2.	Concrete strength	IS : 516	3 cube/beam samples as specified for each age of 7days and 28 days for every 30 m^2 of concrete.
3	Core strength on hardened concrete.	IS : 516	2 cores for every 30 m^3 of concrete.

10.7.4.2 Acceptance of the work shall not be based on a single test result but on statistical basis, such that the lower control limit calculated for a tolerance level of 1 in 15 test results, shall not be lower than the specified minimum strength. The lower control limit is given by the mean value of the set of tests minus 1.61 times the standard deviation. The work shall be taken to meet the specification requirements when the lower control limit is above the specified strength. Where the above requirements are not met with or where the quality of concrete or its compaction is suspected, the actual strength of the hardened concrete in the pavement shall be checked as set forth.

10.7.5 **Joints**

11.7.5.1 All materials required for the joints viz., tie bars, dowel bars, expansion joint filler boards and joint sealing compound shall be checked for

specification requirements before their incorporation in the work. The sealing compound shall conform to IS : 1834.

Dowel bars shall be placed parallel to each other and parallel to the surface and centre line of the pavement. The permissible tolerances in this regard shall be:

± 1 mm in 100 mm for dowels of 20 mm and smaller diameters ;

± 0.5 mm in 100 mm for dowels of diameter greater than 20 mm.

The dowel assembly shall be firmly secured in place to prevent dislocation during concreting. Bulkheads in pairs with tight fitting holes for dowels may be used for this purpose.

All joints spaces and grooves shall conform to the specified lines and dimensions.

During concreting special care shall be exercised to dowels and in the vicinity of joints. Care shall also be taken to ensure that joints do not cause any discontinuity in the riding surface.

At the end of the curing period before opening to traffic, the joint grooves shall be cleaned thoroughly and sealed as specified in IRC : 57-1974. Care shall be taken to see that the sealing compound is not heated beyond the specified temperature.

10.7.6 **Curing of concrete**

Curing shall commence soon after the finished pavement surface can take the weight of the wet burlap, cotton or jute mats normally employed for initial curing, without leaving any marks thereon. The mats shall extend beyond the pavement edges at least by 0.5 m and be constantly wetted. Initial curing shall be for 24 hours or till the concrete is hard enough to permit labour operations without damage.

Final curing, after the removal of the mats, etc., shall be carried out by wet earth, ponding of water or other means specified. Where water is used for curing it shall be ensured that the entire pavement surface is kept well saturated throughout the specified curing period. Where water is scarce or pavement is on a steep gradient, impervious membrance curing shall be adopted as per details specified.

10.7.7 **Checking the Quality of Hardened Concrete**

Soon after the initial curing period, the surface of the hardened concrete shall be checked for surface regularity in accordance with the procedure set forth in the relevant clause of CPWD specification 2000. Surface irregularities beyond the permissible tolerances shall be rectified as indicated in IRC : 15-1970.

Where the strength of concrete tested vide Clause 10.8.4. falls below the specified limits or where the quality of concrete or its compaction is suspected, the actual strength of the hardened concrete shall be ascertained by carrying out tests on cores cut from the hardened concrete. Frequency of testing shall be as indicated in Table. Crushing strength tests on cores shall be corrected for height-diameter ratio and age for obtaining the corresponding cube strength at 28-days in accordance with the procedure given in IRC : 15-

1970. The corrected test results shall then be analysed for conformity with the specification requirement on the lines of Clause 10.7.4.1.

10.7.8 **Reinforcement**

Reinforcing steel, where required to be provided, shall be checked for specification requirements before incorporation in the pavement. Reinforcement shall be placed as specified. Due care shall be taken to ensure that the reinforcement is not displaced during concreting operations.

10.8 **Permanent Traffic Signs**

Permanent traffic signs, direction and place identification signs shall be located where ever directed by the Architect/Project Manager according to his drawings or direction.

10.9 **Speed Breakers**

Where ever directed speed breakers shall be provided as per drawing/direction of the Architect/Project Manager.

10.10 **Kerbs and Channels stones**

Kerbs and channels shall be either cast in situ or precast as shown on the drawings. These kerbs shall be laid on a prepared foundation of concrete as given in item and packed with a triangular section haunch of concrete as shown in the drawing. The kerbs shall be jointed at every 1 M. or as shown in the drawing and painted to follow road marking.

The kerbs to be fitted raised from finished carriage way level as shown in the drawing.

10.11 **Marking of Road and Traffic Boards**

The contractor shall mark all roads and parking areas with road marking paint as shown on the drawings.

10.12 **Mandatory Tests- Appendix**

Physical requirements and other mandatory tests for coarse aggregate, fine aggregate, binding material and bitumen.

Material Frequency	**Test**	**Test Method**	**Requirement**
Coarse aggregate for sub-base	Los Angeles abrasion value OR Aggregate impact value	IS:2386 (Part-IV) Max. 60% IS:2386 (Part-IV) Max.50%	As required by the Architect/Project Manager -Do-
Coarse aggregate for base coarse	a) Los Angles abrasion value OR	IS:2386 (Part-IV) Max.50%	-Do-

	Aggregate impact value b) Flakiness index	" Max. 40% IS:2386 (Part-I) Max.15%	-Do- -Do-
Grading for coarse aggregate		IS:2386 (Part-I)	-Do-
Fine aggregate for screening		IS:2386 (Part-III)	-Do-

Binding Material

The Binding material to be used in WBM shall comprise of suitable material having PI value less than 6.

LIST OF CODES

The materials and workmanship shall be in accordance with the requirement of the appropriate IS code wherever applicable together with any building regulations or bye-laws governing the works.
The following list is included for guidance only and the omission from the list does not relieve the contractor from compliance there with:

IS 1200	:	Mode of measurement.
IS 269 IS 3812, 1981	:	Ordinary portland cement. Flyash for use as pozzolana and admixtures,
IS 2386	:	Method of test for aggregate for concrete.
IS 516	:	Method of test for strength of concrete
		Coarse and fine aggregate from natural sources for concrete.
IS 1077, 1970	:	Method of test for Bricks.
IS 456	:	Code of practice for plain and reinforced concrete.
IS 1597	:	Code of practice for construction of stone masonry.
IS 1597 PART 1	:	Code of practice for construction of rubble stone masonry.
IS 1130	:	Marble (blocks, slabs and tiles)
IS 287	:	Recommendation for maximum permissible moisture contents of Timber used for different purposes.
IS 1141	:	Code of practice for seasoning of timber.
IS 6313 PART 2	:	Anti-termite measures in buildings, pre-constructional chemical treatment measures.
IS 2571	:	Code of practice for laying in situ cement concrete flooring
IS : 226	:	Structural Steel (Standard Quality)
IS : 451	:	Technical Supply Conditions for Wood Screws
IS : 800	:	Code of Practice for Use of Structural Steel in General Building Construction
IS : 806	:	Code of Practice for Use of Steel Tubes in General Building Construction
IS : 813	:	Scheme of Symbols for Welding
IS : 814	:	Covered Electrodes for Metal Arc Welding of (part I & II) Structural Steel
IS : 816	:	Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel
IS : 822	:	Code of Practice for Inspection of Welds
IS : 961	:	Structural Steel (High Tensile)
IS 73	:	Paving bitumen.
IS 702	:	Industrial Bitumen
IS 1322	:	Bitumen felts for waterproofing and damp proofing.
IS 1609	:	Code of practice for laying damp proof treatment using bitumen felts.
IS 13711 & 13712	:	Ceramic tiles
IS 13630 Part 1 to 13	:	Testing for Ceramic tiles
IS 104	:	Specification for ready mixed painted, brushing, zinc chrome, priming.
IS 137	:	Ready mixed paint, brushing, matt or egg-shell flat, finishing, interior to Indian standard colour as required.
IS 5410	:	Cement paint, colour as required.
IS 6241	:	Method of test for determination of stripping value of road aggregate.
IS 2720	:	Density test of aggregate.

PREAMBLE TO SPECIFICATIONS

GENERAL

The conditions of contract and the drawings shall be read in conjunction with the specifications and matters referred to, shown or described in one are not necessarily repeated in the other. These specifications are comprehensive but may exceed the requirements of this project. Any ambiguity between the General Specifications, the Bill of quantities and contract drawings, shall be referred to the Project Manager for clarification not later than 10 days before the date fixed for delivery of Tenders. Any ambiguity may be referred to the Project Manager after signing of the contract and Project Manager shall give a ruling which shall prevail. No claim for additional cost due to above, however, will be entertained.

Notwithstanding the sub-division of the specification into various headings, every part of it is to be deemed supplementary to every other part and is to be read with it, so far as it may be practicable so to do, or when the context so admits.

In this contract, reference is made to the Indian Standards or CPWD specification as approved by Project Manager and these references shall be deemed to include the latest editions or issue of standards, specifications or By-Law including all revisions upto the date of invitation of Tenders. The contractor shall ensure that all materials and workmanship in so far as they apply to this contract shall comply in every specifications or any other equivalent or specification approved by the Project Manager.

The Contractor shall keep at site copies of all relevant standards and codes of practice referred in these specifications throughout the period of contract. These shall be the latest editions and shall include all revisions/addendums thereof.

Approved Manufacturers: Names of approved manufacturers are given in the specifications.

Reference in the specifications to approved manufacturers shall be construed as establishing a standard of quality and not as limiting competition.

The Contractor shall include in his prices for supplying the item or materials from the approved manufacturers listed or equal and approved.

All items or materials shall be delivered to the site in the manufacturers original unopened containers with the manufacturers brand and name clearly marked on.

All items or materials shall be assembled, mixed, fixed, applied or otherwise incorporated in the works in accordance with the printed instructions of the manufacturer of the item or materials.

Date of construction to be written on all respective items for monitoring curing.

Contractor shall follow the pour card/check list for all the concrete/finishing items on prescribed formats.

SITE DEVELOPMENT AND EARTH WORK

- **The rate of items in this section to include:**

1. Measurement of excavation for payment shall be recorded only for the plan dimensions of the bedding concrete (PCC under foundation) provided in the structure drawings. Excavation for working space and slopes for soil stability shall not be measured and paid.
2. Stacking of excavated earth within the site including handling & rehandling.
3. Site clearance such as clearing of shrubs, brushwood, undergrowth, roots and small trees not exceeding 30cm in girth measured at 1m above ground.
4. Setting out the work, profiles, bench marks etc.
5. Excavation either straight or curved in plan or to any desired shape or slope.
6. Provision of adequate barriers, Signages, lighting, and gangways across excavated area open trenches etc. for protection of workmen and public.
7. Getting out and throwing spoil clear of area being excavated or disposing clear of edge of excavation to avoid falling in, as directed by the Project Manager.
8. Trimming all sides, plumb and square, levelling all bottoms, clearing out loose earth, slips and falls from excavations before concreting.
9. Work at all depths and locations, unless otherwise specified.
10. Bailing, pumping out or removing all water which may accumulate in the excavation from all causes.
11. Necessary shoring, strutting, battening, benching. Contractor to submit methodology & design.
12. Signing guarantee Performa for anti-termite treatment i.e. satisfactory performance for minimum of 10 years from the date of final completion of project on an approved proforma. The guarantee shall be executed and extended by the Contractor and not by the anti-termite agency.
13. Conducting laboratory or field test for soil compaction.
14. Compacted volume of earth shall be measured for payment at true location of filling/ back filling.
15. All excavated material shall be the property of the owner or otherwise as specified in the Items.
16. Excavation and disposal for basement shall be done by mechanical means and equipment.
17. Manual dressing to achieve the final level as directed by structural engineer.
18. Royalty & other taxes payable.
19. Dismantling & disposal of any structure / construction in excavation area.
20. Compliance with all stipulation of technical specification.

CONCRETE WORKS (PLAIN AND RCC)

- **The rates for all items under this section include :**

1. Generally all concrete work shall be as per IS-456 (latest edition) characteristic strength (28 days) shall be 20 N/sq. mm, 25 N/Sq mm, 30 N/Sq mm and 35N/sqmm as may be specified on drawings. The rate of all items to include for mix designs for various strengths and workability and routine cube testing at various stages for strength as required. Cost of concrete admixtures is included in the quoted rates, the use of which shall be approved by the Project Manager. The rates shall include for providing all materials, mixing, placing, compacting, cutting, finishing, placing inserts, holding down bolts and flanges, sleeves, puddle flanges, embedding all services pipes, boxes, hooks etc. as shown in drawings at correct location level with required changes in form work, reinforcement etc., complete. All RCC works and all concrete shall be machine vibrated. Formwork and reinforcement are measured separately. All concrete shall be with 20mm and down graded nominal size stone aggregates except specified otherwise. Curing of the concrete shall be as per IS-456 (Latest Edition). All RCC work will be measured and paid as laid, quantity for both the case by using RMC or by using cast in situ concrete with batching plant. No payment will be made according to the supply quantity.
2. The rate of reinforcement work shall include for handling/ storing clearing of rust, straightening, bending and placing, binding, fixing in proper position at any height/level with 18 gauge annealed binding wires, necessary chairs, spacer bars, wastage and cement mortar cover blocks at proper positions to maintain proper cover as per IS-456 (Latest Edition). Reinforcement shall be bent in accordance with IS-2502.
3. Inverted cantilever, Circular / Curved, offsets, Projection, fins, bands, nibs and sloping members on slab, beams, columns, staircase including drilling, cutting, bonding agent complete to the satisfaction of Project Manager etc.
4. Holes and openings in RCC slab/walls, parapet, masonry works, pockets in machine foundation, beam, parapets, for rainwater pipe or spouts and plumbing pipes shall be left at the time of concrete casting or raising masonry and making good after fixing fixtures.
5. If in the opinion of the Project Manager, any surface other than specified for obtaining patterns in exposed surface in concrete under specific items, is asked to be left unrendered and painted, then the item will not be measured as item concerning exposed surface and no extra for any reason will be allowed.
6. Jointing new work with the existing concrete/brickwork including shuttering and approved bonding agent for construction joints.
7. Reinforcement shall be paid separately by weight actually placed in position as per the bar bending schedule, to be prepared by the contractor and approved by the Project Manger. The weight shall be taken as per IS Code for the particular diameter. Rates quoted for reinforcement shall include for cutting, bending, binding the reinforcement bars in any shape, hoisting to all leads and lifts and placing in any position as per detailed drawings, including providing precast cement concrete cover blocks of required thickness for keeping bars in position. 18 gauge annealed binding wire for tying for reinforcement shall be provided by the contractor. The contractor should cover for this in his overall rate for the reinforcement rates including removing rust, Mill scales, oil, grease, paint etc. from reinforcing bars.
8. Generally in items for form work rate to include for form work, centring, shuttering, boxing propping including special nuts, bolts etc. in perfect line, level, plumb and if required to provide camber, slope and removal thereof. Colourless shuttering oil or grease of approved quality shall be applied to forms before placing steel. Rate to include for any

shapes including offsets/ chamfering in columns, residues, grooves, drip moulds, irregular shapes etc. Mode of measurement shall be in sqm regardless of shape, size and thickness of members. Stripping time for the formwork, centring and dropping shall be as per IS-456 (Latest Edition).

9. Work at all heights, depths & levels irrespective of individual storey.
10. Work in narrow widths, Piece meal/ small work, screeding under floor etc.
11. All staging upto any height and scaffolding work shall comprise of MS Pipes/ Structural steel sections with necessary coupling arrangement. (NO WOODEN BALLIES / PROPS WILL BE PERMITTED). Adequate size foundation blocks / base plates shall be provide below staging members to disperse the loads as per the founding strata.
12. Contractor shall set up on site concrete pump, hoists, tower cranes, passenger elevator, automatic microchips controlled Batching plant of capacity 10 cum per hour or more complete with silos/ stock piles for cement and aggregates, and also a D.G. set to be provided for uninterrupted supply of concrete. Use of batching plant for all concrete work is mandatory.
13. Providing grooves, drip moulds, moulds, chamfers, curved surfaces, and ornamental works in RCC members as per drawing and finishing to specified shape.
14. Forming all expansion and / or construction joints as directed.
15. Contractor to consider in his quoted rates the necessary arrangement e.g. providing and fixing of required quantity of woven mesh at the junction of Beam and Column or any other RCC members to separate two different grade of concrete mixes. No payment shall be made for over flowed richer mix of one RCC member into the other.
16. Use of greater than minimum specified quantities of cement to achieve specified or required mix design.
17. RCC (M20) of all water retaining structures with minimum cement content of 400 kgs. Per cum.
18. Use of plasticiser / super plasticiser (approved by Project Manager) and / or additional cement for pumpable concrete.
19. Non-destructive test for defective concrete as directed by Project Manager, and their remedial measures thereof.
20. Leaving dowels for anchorage of brickwork and other RCC members.
21. Mix designing and testing of all the ingredients of concrete from approved laboratory for each grade, pumpable & non-pumpable concrete.
22. Compliance with all requirements of technical specification.

MASONRY WORKS:

- **The rates for all items under this section to include:**

1. All scaffolding, platforms, ladders, staging and plant required in the execution of work to any height or depth and lift.
2. Hacking and roughening of concrete or other surfaces in contact with masonry for bondage.
3. Leaving out dowels from concrete members for anchorage.
4. Labour providing in beam bed blocks of concrete.
5. Rough cutting and waste.
6. Levelling up and preparing tops of walls for damp proof courses, plinth beams, precast units etc.
7. Raking out joints to specified depths either for plaster or pointing or finishing the joints flush as the work proceeds, as directed.
8. Bedding and pointing wall planes, cills, lintels etc. in or on walls, bedding and pointing drops, window and like structures in cement mortar.
9. Forming chases for edges of concrete floors or other units, for sealing in or other waterproofing layers etc.
10. Holes (cut and formed or left), for fixing pipes, bolts and other inserts and making good including grouting if necessary.
11. Building in holdfasts and such other inserts.
12. Work in steps, pillars (round and squared) and also in circular work.
13. Keeping the work well wetted for ten days.
14. Work at all heights, depths and locations, unless otherwise mentioned.
15. Work in parts / joining old / new work including, toothing applying cement slurry etc complete.
16. Washing and cleaning of brick surface with such chemical as are deemed necessary by the Project Manager for any efflorescence observed in the brick work.
17. Opening for exhaust fan/ rain water pipes/ spouts etc as shown in drawing and/ or as directed at site. No deduction for such opening shall be made.
18. Layout and layout course with flat brick/brick on edge / string coarse wherever required.
19. Any efflorescence observed in Brick Work should be watched on with clean water and treated with such chemicals as are deemed necessary by Project Manager. The Brick Work shall be dismantled if deemed necessary by Project Manager and rebuilt with new bricks including making good all disturbed and damaged work.
20. Providing & laying of Hoop Iron as per specifications..

21 Rate to include for any shapes, fins, projections, shafts, Work in narrow widths, Piece meal/ small work etc. Peace meal work necessitated by coordination & requiring of work of other agencies.

22 Compliance with requirements of technical specification

WATER PROOFING:

- Waterproofing work shall be carried out by the specialise agency as approved by Architect/ Project Manager.
- The rate of all relevant items of water-proofing covered under this section to include:

1. Cleaning, smooth rendering and preparation of surface for laying waterproofing, insulation and other treatments.
2. All cutting, trimming, dressing and waste.
3. Treatment of down take pipes, and other obstructions as shown.
4. Providing 50x50, size chase in wall, parapets etc. at 300mm height from floor finish level for tucking ends of vertical layers of the treatment, filling up the chase with cement mortar 1:4 and preparing a drip mould as per detailed drawing just above the chase.
5. Sealing all joints, corners, junctions of pipes and masonry/ concrete with epoxy putty.
6. Curing/ wetting the surface at least for 10days and gunny bags to be spread wherever required before applicant of subsequent coat.
7. Tapecrete is cementitious polymerised compound manufactured in India in collaboration with FPC Composites Ltd., Canada.
8. Work in narrow widths, junctions and at all locations as shown.
9. Work at all heights and depths.
10. 72 hours Pond testing of treated areas to the satisfaction of Project Manager.
11. Signing guarantee as per approved Performa for waterproofing treatment for 10 years from the date of final completion on non judicial stamp paper. The guarantee shall be executed & extended by the contractor and not by the water proofing agency.
12. Hydro testing for under ground and over head water tanks. The contractor shall get water tanks tested against any leakage by filling the tanks with water and maintaining it for seven days up to free board including cost of water, all necessary arrangements required for filling and emptying the tank after testing.
13. Compliance with requirements of technical specification.
14. Mode of Measurements.

a) Terrace

All measurements will be for roof area only as measured on plan and no additional area for vertical tucking/embedding upto 300mm right from top of finish, providing and making gola, khurrah where ever required shall not be paid extra. The contractors rate will be inclusive of all these to make the work complete.

b) Toilet blocks

Floor: Area of the toilet blocks shall be measured by length x breadth between wall.

Vertical side. The actual area treated shall be measured by length x height.

c) Injection Treatment

Floor: The total area of raft/ floor including the area below walls and projections and projections of treatment, if any shall be measured.

d) Walls: Actual area treated shall be measured.

FINISHING WORKS:

- **The rates for all items under this section include :**

1. Making all construction and expansion joints, curving, curing.
2. Making grooves of any pattern as per drawings or as directed by the Project Manger in plaster and dados including rounding of junctions with floors.
3. In case of wall plaster, dado and skirting, raking out joints, cleaning the surfaces, application of cement slurry, applying plaster, skirting and dado treatment unless otherwise specified.
4. Work on patches, narrow widths, small quantities, curved surfaces, projected/ resets bands, setbacks, offsets, corbels, architraves etc.
5. Extra thickness of plaster over indentations etc.
6. Repairing and finishing the junctions of skirting and dado, with relevant mortar/finish.
7. Finishing the chases, edges of electrical fittings and boxes etc.
8. Use of all scaffolding and cradles, dustsheets and other coverings for the protection of fixtures, fittings, furniture, floors etc. (for all heights and locations).
9. Grooves, bands in plaster, on RCC bands, drip coarse etc. in plaster works as per directions.
10. Cleaning of paint splashes, drops or dirt, glasses, joinery, electric fittings etc., including washing the floor and leaving the premises neat and clean.
11. Work shall be carried out at any elevations all heights, levels, leads, lifts.
12. Enamel paint/ melamine polish application by compressed spray method. All other paint shall be finished with roller.
13. Cutting line of two different finishes should be in straight line or as shown in drawing, bands wherever required.
14. Providing and fixing 300mm wide chicken wire mesh with GI screw and washers at the junctions of two different materials and on all chasing for electrical & plumbing conduits, pipes etc.
15. Cost of waterproofing compound wherever mentioned in Bill of Quantities.
16. Compliance with requirements of technical specification.

MISCELLANEOUS WORKS:

- **The rates for all items under this section include :**

1. Steel forging, reducing to required shape, size and figure, drilling, tapping, counter sinking for screws, filling etc. and satisfactory workmanship required to fabricate, finish, erect and fix in position, all structural steel and iron in a good and perfect manner.
2. Providing all bolts and nuts including holding down and anchor bolts, round, squared or tapered washers, anchor plates, rivets, packing pieces, gusset plates, cleats, wedges, brackets, separators etc. (net weight to be computed and paid).
3. All wastage's and cut pieces.
4. Welding as per specifications and drawings but weight of welds not to be paid.
5. Weight of various members to be taken as standard ISI weights. No allowances being made for rolling margins in steelwork.
6. Providing all spikes, nails, service bolts, clamps, jigs etc.
7. Making all necessary templates, patterns moulds and platforms for layout etc.
8. All smithy work, unloading, getting in, hoisting, erecting and fixing in position at all heights, levels and locations, curve portion.
9. Rigidly inserting and setting in lead or other specified material and fixing into concrete and / or building into brick work while the work proceeds and for all fixing, anchoring, plugging, screwing, bolting etc. including non shrink grout and sealants as may be required or directed.
10. Painting two top coat of Red oxide primer before hoisting and erecting in position.
11. The priming coat is required to be of high grade loosing approved quality of Red Oxide primer to provide a coating having a good rust preventive properties and shall adhere well to the metal surfaces, affording a good foundation for subsequent coats.
12. Bending to required shape of square bars, pipes, angles, plates etc as per drawing.
13. Compliance with requirements of technical specification.

ROAD WORKS:

- **The rates for all items under this section include :**

1. Granular sub-base shall be measured as finished work in position in cubic meters. The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.
2. Water bound macadam shall be measured as finished work in position in cubic meters.
3. Bituminous Priming Coat shall be measured as finished work in square meters.
4. Bituminous Macadam shall be measured as finished work in square meters
5. Dense Bituminous Macadam shall be measured for payment in square meters.
6. Bituminous/Asphaltic Concrete shall be measured for payment in cubic meters.
7. Compliance with requirements of technical specification.

LIST OF APPROVED MAKES OF MATERIALS

1.	Chlorpyriphios	-	DE-NOCIL, Cynamide
2.	Structural Sealant	-	Wacker, Dow Corning, GE
3.	Structural Steel	-	SAIL, TATA.
4.	Reinforcement Steel (TMT (FE 500 Grade)	-	SAIL, TATA
5.	M.S. Pipe, Tubes, Bar, Flats, Angle, Tee Sections	-	SAIL, TATA
6.	Cement (OPC)	-	Ultra Tech, Ambuja, ACC
7.	Concrete admixture	-	Fosroc/ Cico.
8	Polysulphide sealant	-	Pidilite, Chemetall-Rai
9	Bitumen Impregnated Board	-	Shalitex or approved equivalent
10	Polyethylene back up rod	-	Supreme Ind. Ltd. or approved equivalent
11	PVC water stops	-	Fixopan / Sintex
12.	White Cement	-	Birla, J.K
13.	Water proofing compound	-	CICO or approved equivalent
14.	Shuttering Ply	-	Jyoti Ply, Archid, Merino
15.	APP Polymeric Polyethylene Felt	-	'PIDILITE' or approved equivalent
16.	Expanded Polystyrene (Thermocole)	-	Beardshell or approved equivalent
17.	Extruded Polystyrene	-	Iso board ND or approved equivalent
18.	Hessian Based Felt	-	'BITUMAT' or approved equivalent

Note: In the List of recommended above, out of makes mentioned in the list, only 1st make shall be quoted for and used. However, if due to non-availability or any other technical reasons, the alternative make is allowed, it shall be subject to price adjustment.