STANDARD SPECIFICATIONS FOR CLASSIFICATION OF SOILS
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AA: SOIL CLASSIFICATION

1.0 SCOPE

This Specification covers classification of soil for earthwork in excavation and filling for site grading/various civil works like construction of roads, dyke wall, drains and various building structures etc. at talegaon depot.

2.0 ORDINARY SOIL

2.1 Soft Soil/loose Soil

Generally any soil which yields to the ordinary application of pick and shovel, or to phawara, rake or other ordinary digging implements such as:

- Sand, gravel, loam, clay, mud, black cotton soil.
- Vegetation or organic soil, turf, peats, soft shale or loose murrum.
- Mud concrete below ground level.
• Any mixture of soil below ground level.

2.2 Hard / Dense Soil

Generally any soil which requires the close application of picks or Jumpers or scarifier and rippers to loosen the same. Such as:

• Stiff heavy clay, hard shale or compact murrum requiring grafting tool and/ or pick and shovel.

• Shingle and river or nallah bed boulders.

• Soling or roads, paths, etc and hard core.

• Macadam surface of any description(water bound, grouted tarmac , etc)

• Lime concrete, stone masonry in lime or cement mortar below ground level.

• Soft conglomerate.

3.0 SOFT ROCK

This is fissured / disintegrated rocky strata, boulders (volume less than 0.4 Cu.M and more than 0.028 Cu.M) and also which cannot be quarried/excavated by using above manual Tools but can be quarried /excavated manually by using crow bars is classified as soft rock. Soft
rock shall include all kinds of stiff and stratified rock such as shales, laterite, hard conglomerate, lime stone, sand stone, and unreinforced cement concrete below ground level. Soft rock may be quarried or split with crow bar or picks and can also be excavated by rippers, dozers and other mechanical equipment but without the aid of blasting. If required, light blasting may be resorted to for loosening the materials, but this will not any way entitle the material to be classified as "Hard Rock".

HARD ROCK

4.1 Hard Rock (Not Requiring Blasting)

This shall include all types of hard and compact rock having closely spaced fissures or joints on account of which blasting is not considered necessary.

BB : EXCAVATION

1.0 This specification covers in general the scope of excavation for this tender only which is categorically for various civil works carried out at talegaon as a part of construction of new depot facilities at talegaon project.

2.0 The excavation mainly has to be carried out in soft soil
/ top soil i.e. black cotton soil. The over burden top consisting of black cotton soil layer at talegaon to a depth as specified at site by HPCL has to be removed to receive various onward material/structures as per specifications given further in this tender due to its swelling properties.

3.0 The site will be handed over to contractor with tree stems up to 60cm ht approximately having girth 30 to 60 cm approximately, vegetation & bushes. Contractor shall visit the site to ascertain the nature of ground prior to bidding to accept all the responsibilities.

4.0 HPCL shall hand over the Bench Marks at site only. The proceeding activities for setting out of work like plotting grid points with Brick Pedestals on the land, fixing the center point for various works intended to be executed under this tender as per drawing with physical verification with existing structures for distances measurement purpose, setting out the co-ordinates for various works along with RL of main B.M. on brick pedestals etc to the satisfaction of EIC after stripping / clearing the ground for construction activity complete in all respect. All the survey equipments like Total Station Equipment for ascertaining the co-ordinates, reduced levels etc, skilled & qualified surveying manpower, recording &
maintaining the measurement book, tools & tackles etc completely at contractor’s cost to the best satisfaction of HPCL.

5.0 The contractor shall provide at his own cost all the assistance that EIC may require for checking the setting out of works. The contractor shall be solely responsible for the horizontal & vertical alignment, correctness of level, and correctness of every part of work and shall rectify any errors or imperfection therein on instruction of EIC.

6.0 Prior to commencing the excavation, requisite block ground levels of entire plot grid co-ordinate wise shall be taken by contractor at 5m intervals or as directed by EIC. The proper duly signed record for the same shall be maintained.

7.0 HPCL has carried out Soil Investigation Job through M/s DBM geotechnics and constructions private limited. The same shall be provided to successful bidder as guidance in execution of work which may be verified and used suitably at their cost and risk.

8.0 Excavation for various works shall be carried out once setting out of work by Contractor is approved by HPCL. Contractor shall excavate to remove till the
specified depth as per Approved for Construction drawing prepared by Contractor and approved by HPCL. The same shall be confirmed by HPCL in writing to proceed further for refilling the excavated pit with murrum. The carting away and leveling of excavated black cotton earth shall be carried out as per specifications. To minimize / avoid side sloughing and collapse sufficient side slope has to be maintained by Contractor. The excavation for side slope to avoid sloughing and collapse will not be entertained for payment. Any Royalty payment to be made towards excavation shall be made by the Contractor as quoted rates are deemed to include the same in accordance to Bombay Minor Minerals Extraction Rules 1955.

9.0 Soil strata received vide above shall be rolled thoroughly by 10T roller till 95% modified/standard proctor maximum laboratory dry density is attained for road/other works respectively as directed by EIC. Thereupon at corresponding co-ordinates at 5m interval or as directed by EIC, level shall be taken to ascertain the excavated height as instructed by EIC.

10.0 The Bench Mark pillars made by the Contractor should be made to sufficient size, depth and strength to withstand during the entire construction work for the purpose intended.
CC: MATERIAL FOR REPLACEMENT & FILLING (MURRUM)

1.0 This covers the specification for external borrowed earth material i.e. MURRUM for replacement of black cotton soil as directed by EIC. This specification supercedes the other clauses, terms elsewhere mentioned for Murrum in this tender document.

2.0 Only Material considered suitable by HPCL shall be employed for the construction and that consider unsuitable shall be disposed of, as directed by Engineer-in-Charge, at contractors cost and no claim for compensation will be entertain.

3.0 The contractor shall submit samples to cover the best material available in around the vicinity to Engineer-in-Charge / HPCL along with the test reports certifying the criteria as per tender specification for following characteristic for all the samples done in a laboratory / test house like Polytest laboratories, sadashiv peth, pune, Vipanan analytical technologies, prabhat road, pune as guided by Engineer-in-Charge like COEP-Pune or any other govt. agencies preferably:

i) Mechanical analysis or grain size distribution as per
IS: 2720 part IV.
ii ) Liquid limit as per IS: 2720 part V
iii ) Plastic limit as per IS: 2720 part V
iv) Moisture density relationship as per IS: 2720 part VII

4.0 The material (murrum) used for filling shall be free from boulders, lumps, tree roots, rubbish or any organic deleterious materials.

5.0 Material (murrum) approved by HPCL shall only be used for filling purpose.

6.0 Murrum having standard proctor laboratory maximum dry density less than 1.8 gm/cc shall not be used. The murrum shall have a Plasticity Index of 5-17 (medium Plastic) and not more than 20% Fines i.e., Clay.

7.0 Care shall be taken to see that waste material from murrum is disposed of in such a manner that there is no likely hood of its getting mixed with the material proposed to be used for filling.

8.0 The contractor has to make own approach and access roads in the borrow areas (Outside Plant Premises) and to the demarcated filling area (Inside Plant Premises).
9.0 All the royalty payments etc. as deemed admissible to statutory / govt. authorities will be paid by contractor for all the murrum brought for HPCL works.

Contractor shall not be permitted to bring murrum inside HPCL till the following documents are submitted to HPCL:

1. Proof of payment of royalty at prevalent rates as charged by maharashtra govt. at the time of execution.

2. Permission from applicable competent government authorities/district collector as per Bombay Minor Minerals Extraction rules 1955.

3. Obtaining NOC (no-objection certificate) from landowners of proposed site(s) where the murrum will be lifted. Extract 7/12 and village map of the proposed dump site shall be furnished to HPCL. The landowners may be state government, central government, public body, private individual/joint owners etc as applicable. Carting murrum from Gairon land is not allowed in Maharashtra.

It shall be the responsibility for the contractor to produce all such payments, documents to Engineer-in-Charge during submission of running bill. At the end of work no objection certificate from relevant authorities will be submitted to ensure that HPCL is
kept free from all encumbrances.

10.0 Approved murrum material shall be spread in uniform layers not exceeding 20 cm in loose thickness and watered as per OMC.

11.0 After checking the moisture through moisture tester by calcium carbide method in field for OMC, the layers shall be thoroughly compacted by 10MT roller as approved by Engineer-in-Charge till 95% of Modified proctor maximum laboratory dry density is achieved. Each layer shall be tested in field for density and accepted by HPCL subject to 95% of respective laboratory dry density being achieved. A minimum of 1 test per 100 sq. mt. of compacted area in field shall be conducted for dry density. Required equipments like Moisture Tester, Oven, Electronic weighing machine, proctor apparatus shall be supplied by Contractor.

12.0 Successive layers of filling and watering will not be permitted until the layer below has been compacted thoroughly to satisfy the requirements of the specifications. If the layer fails to meet the required density, it shall be reworked till the required density is achieved.
13.0 The filling shall be finished in conformity with alignment levels, cross section and dimension as shown in the drawing. Earth embankment shall be filled suitably on both sides to achieve the required compaction and this extra filling shall be dressed after compaction, in conformity with alignment, levels, cross section and dimensions as shown in the drawing. No extra payment shall be made in this regard.

14.0 The excavated black cotton soil and / or unusable debris from excavation shall be loaded, transported outside HPCL Depot premises which are covered under the item for Disposal of earth.
STANDARD SPECIFICATIONS
FOR
DISPOSAL OF EARTH
AND
BRINGING MURRUM
1.0) INTRODUCTION

THIS SPECIFICATION ESTABLISHES MINIMUM REQUIREMENT FOR CARTING AWAY THE EARTH OUTSIDE THE HPCL PREMISES GENERATED FROM VARIOUS CIVIL WORKS THAT HAS BEEN CARRIED OUT AS PART CONSTRUCTION OF NEW DEPOT FACILITIES AT TALEGAON PROJECT & BURROWING GOOD QUALITY MURRUM FROM OUTSIDE. IT SHALL BE THE SOLE RESPONSIBILITY OF CONTRACTOR TO FOLLOW BOMBAY MINOR MINERAL EXTRACTION RULES 1955.

2.0) OBTAINING PRIOR CLEARANCE FROM APPROPRIATE LOCAL/ STATUTORY/GOVERNMENT AUTHORITIES, AS PER PREVAILING RULES AND REGULATION AS APPLICABLE IN THE STATE OF MAHARASHTRA FOR CLEARANCE/CARTING AWAY OF THE EARTH TO UNOBJECTABLE SITE(S) IDENTIFIED BY CONTRACTOR OUTSIDE HPCL IRD PREMISES & BRINING MURRUM OF REQUIRED SPECIFICATION AS PER THIS TENDER BY REMITTING NECESSARY ROYALTY/SEIGNORAGE CHARGES FOR THE ENTIRE VOLUME BILLED BY CONTRACTOR AS PER BOMBAY MINOR MINERALS EXTRACTION RULES 1955. CONTRACTOR SHALL NOT BE PERMITTED TO WORK TILL FOLLOWING DOCUMENTS ARE SUBMITTED TO HPCL:

2.1) PROOF OF PAYMENT OF ROYALTY FOR THE ENTIRE VOLUME AT PREVAMENT RATES AS CHARGED BY MAHARASHTRA GOVT. AT THE TIME OF EXECUTION.
2.2) PERMISSION FROM APPLICABLE COMPETENT GOVERNMENT AUTHORITIES AS PER BOMBAY MINOR MINERALS EXTRACTION RULES 1955 FOR THE WORK.

2.3) OBTAINING NOC (NO-OBJECTION CERTIFICATE) FROM LANDOWNERS OF PROPOSED SITE(S) WHERE THE CLEARED EARTH IS PROPOSED TO BE DUMPED. EXTRACT 7/12 AND VILLAGE MAP OF THE PROPOSED DUMP SITE SHALL BE FURNISHED TO HPCL. THE LANDOWNERS MAY BE STATE GOVERNMENT, CENTRAL GOVERNMENT, PUBLIC BODY, LOCAL BODY, PRIVATE INDIVIDUAL/JOINT OWNERS, ETC AS APPLICABLE.

2.4) PAYMENT OF DISPOSAL FEES TO HPCL TOWARDS INCOME GENERATED BY SALE OF BLACK COTTON SOIL/ EARTH POSSESSING FERTILITY PROPERTY TO LANDOWNERS OF SITE(S) OUTSIDE HPCL PREMISES. HPCL WILL HOWEVER ISSUE NECESSARY DECLARATION REGARDING QUANTITY ON THEIR LETTERHEAD.

3.0) THE FOLLOWING SHALL BE THE RESPONSIBILITIES OF CONTRACTOR:

3.1) LIASON WITH RELEVANT AUTHORITIES FOR CARRYING OUT PANCHNAMA AND ANY OTHER VERIFICATION WORK

3.2) MAINTAIN REGISTERS FOR RECORD OF VOLUME OF DUMPERS, NO. TRIPS AND OTHER DETAILS AS PER REQUIREMENTS OF HPCL. CONTRACTOR SHALL ALSO PROVIDE A LIST OF SURVEY NOS. WITH LAND OWNERS ON
WHO’S LAND THE DUMPED EARTH IS BEING CARTED AWAY. IT SHALL BE THE SOLE RESPONSIBILITY OF CONTRACTOR TO OBTAIN CORRECT AND PRECISE INFORMATION AND COMPLY WITH ALL APPLICABLE RULES AND REGULATIONS PREVALENT IN MAHARASHTRA.

HPCL SHALL NOT ENTERTAIN ANY CLAIMS WHATSOEVER IN THIS REGARD:

3.3) SUBMIT APPLICATION ON BEHALF OF HPCL, LIASON AND OBTAIN PERMISSION FROM COLLECTOR/COMPETENT AUTHORITY AS PER BOMBAY

3.4) ARRANGE FOR SITE VISIT BY THE RESPECTIVE OFFICIAL OF STATE GOVERNMENT & CONDUCT PANCHNAMA, OBTAIN DEMAND NOTE.

3.5) REMIT APPLICABLE ROYALTY/SEIGNORAGE FEES AMOUNT VIDE CHALLAN IN LOCALSTATE BANK OF INDIA BRANCH IN ADVANCE OF COMMENCING CARTING AWAY.

3.6) MAINTAIN PROPER DOCUMENTATION OF NO. OF TRIPS/VOLUME OF TRUCKS/TIPPERS FOR PURPOSE OF CROSS-CHECK/ RECONCILIATION ON DAILY BASIS.

3.7) ANY OTHER CONDITIONS/STIPULATIONS LAID DOWN IN THE LETTER GRANTING PERMISSION FROM THE APPROVING AUTHORITY.

3.8) SUBMISSION OF INSURANCES PERTAINING TO JCB/POCLAIN, DUMPERS, TRUCKS,
TRACTOR TROLLEYS; MEDICLAIM POLICY FOR THE ENTIRE WORKFORCE INCLUDING DRIVERS, HELPERS, LABOUR AND SUPERVISOR(S) AS ESI IS NOT APPLICABLE FOR LONI IRD; OTHER INSURANCE POLICIES AS STIPULATED IN THE TENDER DOCUMENT.

3.9) DEPLOYMENT OF JCB/POCLAIN, DUMPERS, TRUCKS, TRACTOR TROLLEYS AND ANY OTHER EQUIPMENT AS REQUIRED FOR THE WORK INCLUDING SUPPLY OF FUEL, LUBES, BATTERY, ETC, PAYMENT OF SALARY, APPLICABLE BENEFITS INCLUDING PF, BOARDING&LODGING, IF ANY AND OTHER INCIDENTAL EXPENSES, IF ANY. IDENTIFIED IN LINE WITH SL.NO.2 ABOVE

3.10) CLEARING OF DUMPED EARTH, LOADING INTO DUMPERS, TRUCKS, TRACTOR TROLLEYS, ETC., PREPARATION OF NECESSARY OUTGATE PASS, TRANSPORTATION TO UNOBJECTIONABLE SITE(S) FOR ALL LEADS AND LIFTS, UNLOADING/DUMPING&LEVELLING AS APPLICABLE AT SITE(S) MINOR MINERAL EXTRACTION RULES 1955 AND OBTAINING NECESSARY APPROVALS FOR THE JOB.

3.11) OBTAINING NO CLAIM-NO DUE CERTIFICATE FROM LANDOWNERS OF SITE(S) WHERE THE UNUSABLE EARTH WAS DUMPED & FROM WHERE MURRUM IS BROUGHT.
3.12) SITE CLEANING INSIDE HPCL PREMISES DURING THE COURSE OF WORK AND AFTER COMPLETION OF CLEARANCE/CARTING AWAY.

3.13) OBSERVATION OF SATISFACTORY REDUCED LEVELS/FINISHED LEVELS INSIDE HPCL PREMISES AS INDICATED IN THE TENDER. THE REDUCED LEVELS INDICATED SHALL BE WITH RESPECT TO THE PERMANENT BENCHMARK.

3.14) SAFETY: UTMOST SAFETY HAS TO BE OBSERVED AS THE ENTIRE WORK IS REQUIRED TO BE CARRIED OUT IN AN OPERATING TERMINAL. CONTRACTOR SHALL PROVIDE FLAME ARRESTORS FOR TRACTORS, JCB/POCLAIN, AND TRUCKS AND FOR ANY DIESEL DRIVEN EQUIPMENT. ALSO REQUISITE PERSONNEL SAFETY EQUIPMENT LIKE SAFETY HELMETS (WITH ISI MARK), GUM BOOTS ETC., SHALL BE PROVIDED BY THE CONTRACTOR FOR HIS LABOURERS. UTMOST SAFETY HAS TO BE OBSERVED AT BORROW PITS & DUMP YARDS OUTSIDE HPCL PREMISE.

3.15) ENTRY PASS AND WORK PERMIT: CONTRACTOR HAS TO ARRANGE FOR ENTRY PASS FOR THEIR PERSONNEL IN CONSULTATION WITH HPCL OFFICER. FURTHER, HOT/COLD WORK PERMIT AS APPLICABLE TO BE OBTAINED FROM HPCL OFFICER PRIOR TO COMMENCEMENT OF WORK ON EACH DAY/SHIFT AS APPLICABLE.
NOTE: THOUGH HPCL HAS MADE EVERY ATTEMPT TO LIST OUT ALL THE STEPS INVOLVED IN OBTAINING CLEARANCES FROM LOCAL/STATUTORY/STATE GOVERNMENT AUTHORITIES IT SHALL BE THE SOLE RESPONSIBILITY OF THE BIDDER(S)/CONTRACTOR TO INDEPENDENTLY ASSESS THE SAME AND QUOTE ACCORDINGLY. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR SATISFACTORY COMPLETION OF WORK INCLUDING COMPLYING WITH ALL RULES AND REGULATIONS PREVAILING IN THE STATE OF MAHARASHTRA. ANY DEVIATION WITH RESPECT TO THE PROCEDURES SHOWN HEREIN ABOVE SHALL BE BROUGHT OUT BY THE BIDDER VERY CLEARLY IN THE UNPRICED BID.

4.0) HPCL SCOPE:

1) ARRANGEMENT OF ENTRY PASSES/WORK PERMITS TO THE CONTRACTOR.

2) CO-ORDINATION WITH HPCL TERMINAL FOR ALL SAFETY AND SECURITY RELATED MEASURES DURING THE COURSE OF THIS WORK.
STANDARD SPECIFICATION FOR WBM AND BITUMEN PREMIX ROADS
CONTENTS

1.0 SCOPE

2.0 REFERENCE CODES AND STANDARDS

3.0 EARTHWORK IN FILLING

4.0 FILLING WITH MURRUM/SAND

5.0 WBM SUB-BASE/BASE COURSE

6.0 CONSTRUCTION OF SHOULDERS OF BERMS

7.0 BITUMEN PREMIX CARPET
1.0 SCOPE

This specification covers the material and construction details for earthwork in filling for embankments, filling with sand/murrum, WBM sub-base, WBM base course and shoulders for roads and flexible pavements.

2.0 REFERENCE CODES AND STANDARDS

2.1 B.I.S. Specifications.

IS: 2720 – Methods of Test of Soil.

2.2 Indian Road Congress Standards.

IRC: 19 – Standard Specification and Code or Practice for Water Bound Macadam

3.0 EARTH WORK IN FILLING

3.1 Material

Only material considered suitable by the Engineer-In-Charge shall be employed for the construction and that considered unsuitable shall be disposed off as directed by Engineer-In-Charge at his own cost and no claim for compensation will be entertained. The contractor shall give the samples of earth, he proposes to use for filling along with the following characteristics of the sample to Engineer-In-Charge prior to collection and use, for approval.
i) Mechanical analysis or gain size analysis as per IS: 2720 Part IV.

ii) Liquid limit as per IS: 2720 Part V.

iii) Plastic Limit as per IS: 2720 Part V.

iv) Moisture density relationship as per IS: 2720 Part VIII.

The material (murrum) used for filling shall be free from boulders, lumps, tree roots, rubbish or any organic deleterious matter.

Murrum having standard proctor laboratory maximum dry density less than 1.8 gm/cc shall not be used. The murrum shall have a Plasticity Index of 5-17 (medium Plastic) and not more than 20% Fines i.e., Clay.

Care shall be taken to see that unsuitable waste material is disposed off in such a manner that there is no likelihood of its getting mixed with the materials proposed to be used for filling.

The work shall be so planed and executed such that the best available material is reserved for the top portion of embankment.

3.2 Filling for Embankments and Shoulders
3.2.1 The area where filling is to be placed must be cleared of all loose material and virgin soil must be exposed. Such exposed surface must be consolidated properly to obtain 90% of maximum laboratory dry density of the soil. All soft patches must be worked out to remove the soft soil and selected approved earth must be filled back and compacted.

3.2.2 Payment for the removal of loose top soil as described in clause 3.2.1 above shall be included in the item for earth work in filling. No separate payment for consolidation of exposed ground surface will be made. The rate quoted for the earth fill shall be inclusive of the cost of clearing and stripping, consolidation including watering, testing etc. of the exposed ground.

3.2.3 Approved fill material (murrum) shall be spread in uniform layers not exceeding 20 cms in loose depth for embankment filling. Shoulder construction shall be so organized as to keep pace with the construction of different layers of the pavement, which may require fill thickness less than 20cm. All clods, lumps etc. shall be broken before compaction.

3.2.4 In general the murrum shall be spread uniformly over the entire width of embankment or shoulders as the case may be. For large embankments, the spreading of soil shall be as directed by the Engineer-In-Charge.
3.2.5 Successive layers of filling shall not be placed until the layer under construction has been thoroughly compacted to satisfy the requirements laid down in this specification.

3.2.6 Prior to rolling, the moisture content of material shall be brought to within plus or minus 2% of the optimum content as described in IS: 2720 –Part-VIII. The moisture content shall preferably be on the wet side for potentially expensive soils.

3.2.7 After adjusting the moisture content as described in Clause 3.2.6, the layers shall be thoroughly compacted by means of rollers till 95% of modified proctor density is obtained as per IS:2720 Part VIII.

3.2.8 Each layer shall be tested in field for density and accepted by Engineer-In-Charge subjected to achieving the required density before laying the next layer. A minimum of one test as per 500 M 2 areas for each layer shall be conducted.

3.2.9 All type of rollers that should be employed for compaction shall be as per direction of Engineer-In-Charge.

3.2.10 If the layer fails to meet the required density, it shall be reworked to the material shall be replaced and method of construction altered as directed by Engineer-In-Charge to obtain the required density.
3.2.11 The filling shall be finished in conformity with alignment, levels, cross-section and dimensions as shown in the drawings.

3.2.12 Extra material shall be removed and disposed off as by Engineer-In-Charge.

3.2.13 Tolerance

Embarkment and shoulders for roads, units etc. shall be carried to within a tolerance of cm. from final lines but shall be to required roads and slopes.

3.3 Payment

3.4.1 Payment for filling shall be made on cubic meter of volume calculated on the basis of cross-section plotted from the level of the ground surface prepared as described in clause 3.2 above and from where filling is to be carried out and the levels reached after filling and due consolidation.

3.4.2 Rates of embarkment shoulder or fill formation shall include cost of breaking clods, watering, consolidation, providing testing apparatus and testing the degree of consolidation, providing and operating, including POL and operator charges of necessary road rollers and other equipment, dressing and leveling of sides and top surfaces etc.
4.0 FILLING WITH SAND/MURRUM

4.1 Sand for filling shall preferably the locally available sand, clean and free from any chemical or other impurities. Murrum for filling shall be clean and well graded. Sand/Murrum shall not contain any vegetation, organic, clayey or other material and shall be obtained from a source approved by Engineer-In-Charge.

4.2 Murrum/Sand shall be spread in layers not exceeding 20 cm in loose thickness over the areas. Each layer shall be uniform in density, quality of material and moisture content as per IS: 2720 Part VIII.

4.2.1 In case of pure sand, flooding with water is permissible.

4.3 Compaction of each layer shall be by mechanical means as per directions of Engineer-In-Charge. Only in accessible reaches shall be worked manually. Each layer shall be uniformly compacted obtain 95% of modified proctor density of the material. If the material fails to achieve the required density, the layer shall be reworked with necessary alteration in compaction, so that the required compaction is obtained. A minimum of one test as per 500 M 2 areas for each layer shall be conducted.

4.4 Subsequently layers shall be placed only after the layer already laid has been compacted to the required density and approved by Engineer-In-Charge.
4.5 The finished surfaces must be dressed to required grade and slope. Excess material must be removed from compaction site, as directed by Engineer-In-Charge.

4.6 Payment

Payment for sand/murrum filling shall be made on the basis of volume of fill, after placement and compaction. The rate quoted shall include cost of sand/murrum, royalties, transportation, handling, compacting, watering, testing at various stages, dressing removal of surplus material and any other incidental to this.

5.0 WATER BOUND MACADAM SUB BASE/BASE COURSE

The sub-base course shall consist of one or more layers, each or 100 mm compacted thickness.

The base course shall consist of one or more layers, each of 75 mm compacted thickness.

5.1 Stone Aggregate for WBM

5.1.1 The coarse aggregate shall be hard, crushed or broken stone metal from quarries approved by Engineer-In-Charge, it shall be hard durable and free from flat elongated, Soft and disintegrated particles. It shall not have excess of dirt and other objectionable matter. The quality, size, and grading of the coarse aggregate shall be
conforming to IRC 19: STD Spec and code of practice for WBM.

a) The grading of the coarse aggregate for the sub-base course shall be as follows:

<table>
<thead>
<tr>
<th>Size Range</th>
<th>Sieve Designation(IS: 460)</th>
<th>% by weight Passing the sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>90mm to 45mm Grade-1</td>
<td>125 MM</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>90 MM</td>
<td>90-100</td>
</tr>
<tr>
<td></td>
<td>63 MM</td>
<td>25-60</td>
</tr>
<tr>
<td></td>
<td>45 MM</td>
<td>0-15</td>
</tr>
<tr>
<td></td>
<td>22.4 MM</td>
<td>0-5</td>
</tr>
</tbody>
</table>

b) The grading of the coarse aggregate for the base course shall be as follow:

<table>
<thead>
<tr>
<th>Size Range</th>
<th>Sieve Designation(IS: 460)</th>
<th>% by weight Passing the sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>63mm to 45mm Grade-2</td>
<td>90 MM</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>63 MM</td>
<td>90-100</td>
</tr>
<tr>
<td></td>
<td>53 MM</td>
<td>25-75</td>
</tr>
<tr>
<td></td>
<td>45 MM</td>
<td>0-15</td>
</tr>
<tr>
<td></td>
<td>22.4 MM</td>
<td>0-5</td>
</tr>
</tbody>
</table>
5.1.2 a) Physical requirement of coarse aggregates for sub-base course shall be as below:

i) Los Angles Abrasion Value - 60% (Maximum)

Or

ii) Aggregate Impact Value - 50% (Maximum)

b) Physical requirement of coarse aggregates for base course shall be as below:

i) Los Angles Abrasion Value - 50% (Maximum)

Or

Aggregate Impact Value - 40% (Maximum)

ii) Flakiness index value - 15% (Maximum)

Samples of test shall be representative of the material to be used and collected as per IS: 2430.

5.1.3 The aggregate shall be stacked at the road sided on firm, well drained ground in regular stacks, as directed by Engineer-In-Charge. The various grades shall be stacked separately and
contamination by earth and other extraneous matter shall be prevented effectively.

5.2 Binding Material Murrum

5.2.1 The binding material shall be clean, dry murrum free from leaves, organic matter any deleterious material.

5.2.2 It shall be obtained from quarries approved by Engineer-In-Charge.

5.3 Spreading Coarse Aggregates

5.3.1 The sub grade or sub-base to receive WBM coarse shall be prepared to the required grade and camber. Before starting with WBM construction, side shoulders shall be constructed in advance to a thickness corresponding to the compacted layer of the WBM coarse for lateral confinement of aggregate. After shoulders are ready, their inside edge shall be trimmed vertical to receive the aggregate. The practice of constructing WBM in a trench section excavated on the embankment/formation must be avoided.

5.3.2 The coarse aggregate shall be spread uniformly and evenly on the prepared base in required quantities from the stacks. The aggregate shall be spread to proper profiles by using templates across the road about 6m apart.
5.3.3 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 surface shall be checked from time to time, during the spreading and rolling of the coarse aggregate to ensure a finished surface without variation greater than 12 mm, when a 3 meter long straight edge is laid parallel to centre line of the road.

5.3.4 The WBM layer shall be tested by depth blocks. No segregation on large or fine particle shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pocket of fine materials.

5.3.5 The coarse aggregate shall not be spread in lengths more than 3 days average work in advance of the rolling, spreading murrum and bonding of the preceding section.

5.4 Rolling Road Metal

5.4.1 Immediately following the spreading of the coarse aggregate, it shall be compacted to full width by rolling with either three wheeled power roller of 8 to 10 tone weight or equivalent vibratory roller true to the line and camber as shown in the drawing. The course shall not be rolled when the sub-grade is soft or yielding or the rolling causes a wave like motion in the base course or sub-grade. When rolling develops irregularities that exceed 12mm when tested with a 3 meter straight edge, the irregular, surface shall be loosened and then aggregate added to or remove from it as required and the area rolled until it gives uniform surface conforming to the desired
cross-section and grade. The surface shall also be checked transversely by template and any regulations corrected as above. The use of murrum to make up depression shall not be permitted.

5.4.2 The rolling shall begin from edges with roller running forward and backward until the edges have been firmly compacted. The rolling shall then progress gradually from edges to the centre parallel to the centre line of the road lapping uniformly each proceeding rear wheel track by one half widths and shall continue until the entire area of the course has been rolled by the rear wheel. On the super elevated portion of road, the rolling shall commence from the lower edge and progress gradually towards the upper edge of the road.

5.4.3 Rolling shall be discontinued when aggregate are thoroughly keyed and creating of stone wheel of roller is no longer visible partially compacted with sufficient void space in them to permit application of screenings. Slight sprinkling of water may be done if required.

5.5 Screenings

5.5.1 Material

Screening to fill the voids in the coarse aggregate shall, as far as possible be the same material as the coarse aggregate. Where it is decided by the Engineer-In-Charge to use other materials, the same shall be predominantly non-plastic materials such as Kankar nodules, gravel (other than river-
born rounded aggregate) or murrum, provided that the liquid limit and plasticity index of such material is below 20 and 6 respectively, and the fraction passing 75 micron siever does not exceed 10 percent.

5.5.2 Grading requirements of screenings

<table>
<thead>
<tr>
<th>Size of Screening</th>
<th>Siever Designation</th>
<th>Percent by weight passing the sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.2mm</td>
<td>13.2mm</td>
<td>100</td>
</tr>
<tr>
<td>11.2mm</td>
<td>95-100</td>
<td></td>
</tr>
<tr>
<td>5.6mm</td>
<td>15-35</td>
<td></td>
</tr>
<tr>
<td>180 micron</td>
<td>0-10</td>
<td></td>
</tr>
</tbody>
</table>

This grading however shall not be mandatory, in case either murrum or gravel is used as screenings.

5.6 Application of Screenings

5.6.1 After the coarse aggregate has been rolled as described in Clause 5.3, screenings shall be applied uniformly and 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 roll will cause them to settle into the voids of the coarse aggregates.

5.6.2 The screening shall not be dumped in piles on coarse aggregate but shall be spread uniformly in successive thin layers either by the spreading motion of hand shovels or by mechanic spreaders.

5.6.3 The screenings shall be applied at a uniform and 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 both may be used. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface making the filling of voids difficult or preventing the direct bearings 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 day’s operation and shall continue until no more screening can be forced into the voids of the coarse aggregates. Damp and wet screening shall not be used under any circumstances.

5.6.4 The quantity of screenings used shall be such as to fill all voids in the water bound macadam courses.

5.7 Sprinkling and Grouting

5.7.1 After spreading the screenings, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screening into voids and to distribute
them evenly. The sprinkling, sweeping and rolling shall be continued and additional screenings applied where necessary until the coarse aggregate are well compacted and grout of screenings and water form a wave ahead of wheels of the roller. Care shall be taken to see that the base of sub-grade does not get damaged due to the addition of the excessive quantity of water during the construction.

5.8 Binding Material

5.8.1 Binding material to prevent reveling of WBM shall consist of fine grained material possessing P.I. Value upto 6.

5.8.2 Application of binding material shall not be necessary where murrum or gravel is used as screenings.

5.8.3 Binding material shall be obtained from quarries/sources approved by the Engineer-Ion-Charge.

5.9 Application of Binding Material

5.9.1 After the application of screenings as described above the binding material shall be applied at a uniform and slow rate (in two or more successive thin layers) so as to ensure filling of all voids.

    After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with hand brooms/mechanical brooms or both so as to fill the voids properly. This shall be followed by rolling
with 1 6-10 tonne roller during which water shall be applied to the wheels to wash down the binding material that may get stuck to them. The spreading, rolling and brooming of binding material shall be performed on section which can be completed within one day’s operation and shall continue until no more binding material can be forced into the voids of the coarse aggregates until the slurry of binding material and water forms a wave ahead of the wheels of moving roller. Damp and wet binding material shall not be used under any circumstances.

5.9.2 The quantity of binding used shall be such as to fill all voids in the water bound macadam.

5.9.3 Payment

Payment for laying WBM shall be made on square meter basis of each layer of WBM laid, measured after consolidation and finishing. Rate shall include supply of all materials, royalty, taxes, handling, transportation, stacking, spreading metal in layers, including screening, consolidation by power roller, binding with murrum or other approved binding material, cost of carrying the material from stack to work for all leads and lifts, providing and running roller etc. complete as per specification and satisfaction of Engineer-In-Charge.

5.9.4 Subsequent Layers of WBM
Before laying the subsequent layers of WBM, the surface shall be scarified and reshaped to the required camber and profile and all ruts, depressions pot holes etc. made good. The second layer shall be laid after the surface preparation is approved by Engineer-In-Charge. The specification and mode of measurement for subsequent layers of WBM will be similar to that described before.

5.9.5 Payment

Payment for surface preparation, rectification of damaged portions of proceeding layers of water bound macadam and filling in ruts and depressions shall he made in M2 or M3 as per schedule of items. Payment for subsequent layer of WBM shall be made on M2 as per CI.5.9.3

6.0 CONSTRUCTION OF SHOULDERS OR BERMS

6.1 After the WBM course is laid and compacted, the existing surface at side berms or shoulders of the roadway must be scarified. Fresh quantity of approved earth must he spread in layers for building up of berms upto the required level and scope.

The earth must be consolidated by at least three passes of an 8-10 tonne road roller. The edges must be well consolidated by suitable means to prevent edge slips and the work properly trimmed and dressed.

7.0 BITUMEN PREMIX CARPET

7.1 Material
7.1.1 Coarse aggregate

The aggregate shall consist of crushed stone of Clean, hard, tough, durable rock of uniform quality and shall be clean, free from excess of dust, flat or elongated pieces, soft or disintegrated stone, clay or other deleterious matter. The size of aggregate shall be as below

<table>
<thead>
<tr>
<th>Ph</th>
<th>Coarse aggregate size</th>
<th>Quantity required per 100 m2 of premix bituminous carpet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. for 35 mm thick 1st layer</td>
<td>25 mm and downsize</td>
<td>5.5 m3</td>
</tr>
<tr>
<td>2. for 15 mm thick 2nd layer</td>
<td>12 mm and downsize</td>
<td>2.0 m3</td>
</tr>
</tbody>
</table>

The grading for the coarse aggregates mentioned above for premix carpet shall comply with respective IRC code.

Physical requirement of coarse aggregates for premix bituminous carpet shall be as below:

i) Los Angles Abrasion Value- 40% (Maximum)

Or

Aggregate Impact Value- 35% (Maximum)
ii) Flakiness index value -30% (Maximum)

Samples of test shall be representative of the material to be used and collected as per IS: 2430.

7.1.2 Binder
The Binder shall be bitumen of penetration 80/100 conforming to IS: 73. The bitumen shall be collected on roadside drums. Any drum leaking or damaged shall not be accepted.

Quantity of bitumen required per 100 m² premix carpet will be as given below:

<table>
<thead>
<tr>
<th>Bitumen 80/100 grade</th>
<th>Quantity required per 100 m² of premix carpet</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. for 35 mm thick 1&lt;sup&gt;st&lt;/sup&gt; layer</td>
<td>269 kg</td>
</tr>
<tr>
<td>2. for 15 mm thick 2&lt;sup&gt;nd&lt;/sup&gt; layer</td>
<td>110 kg</td>
</tr>
</tbody>
</table>

7.2. LAYING

7.2.1 Preparation of Road Surface
The existing surface shall be thoroughly cleaned of dust, loose materials caked mud and foreign matter with the help
of wire brush, chisel, picks etc., before laying the tack course. The cleaning shall be carried out in such a manner as to expose the stone metal to a depth of 1 to 2mm without dislodging the interlocking of the metal. All dust and other material thus removed shall be carried away and dumped at suitable places as directed by the Engineer-in-charge.

7.2.2 If Pot holes or ruts are found on the existing road surface, these irregularities must be filled in with premix chippings and will rammed about a week before the carpet is laid.

7.3 Tack Coat

7.3.1 The bitumen shall be heated in asphalt boiler to 177° - 188° C and shall be spread uniformly at the rate of 1 kg/m² by the means of sprayers. The applied binder shall be evenly spread.

7.3.2 The tack coat shall be applied just ahead, keeping pace with laying of premix carpet.

7.4 Preparation of Premix

7.4.1 50 mm thick asphalt bituminous carpet should be laid in two layers of 35 mm and 15 mm thickness with following specifications.

**Ist Layer** (35 mm thick) – coarse aggregate 25 mm and downsize @ 5.5m³ and 80/100 grade bitumen @ 269 kg per 100 m² of premix carpet.
II nd Layer (15 mm thick) – coarse aggregate 12 mm and downsize @ 2.0 m³ and 80/100 grade bitumen @ 110 kg per 100 m² of premix carpet.

7.4.2 Mechanical Mixers shall be generally used for preparation of premix improvised hand mixing drums may be used if permitted by the Engineer-in-charge.

7.4.3 Stone chippings of specified size shall be thoroughly mixed dry in the Mixer at the rate indicated above. Binder heated at temperature suitable for the grade of bitumen is added to the mixer drum at the specified rate per 100 m³ of surface and thoroughly mixed till the stone chips are completely coated with the Binder.

7.4.4 The premix shall be emptied on the wheel barrows or stretchers and carried to work site.

7.5 Spreading of Premix

Immediately after applying the tack coat, the premix shall be spread in two layers as mentioned above with rakes to the required thickness land distributed evenly by means of a drag spreader. The camber shall be checked by means of camber board and the unevenness shall be rectified.

7.6 Rolling

7.6.1 When the premix has been laid for a length of 15-20 meters, rolling shall be commenced with tandem rollers (8
to 10 tonnes). Rolling should commence from edges and proceed towards center longitudinally.

7.6.2 The wheels of roller shall be continuously moistened to prevent the premix adhering to the wheels and being picked up.

7.6.3 After the preliminary rolling and honey combing, high spot of depressions shall be rectified by adding or removing the premix as per requirements and the surface shall be rolled again to compaction. Camber shall be checked at every stage and any defects found shall be rectified. Excessive rolling shall be avoided.

7.7 Seal Coat

7.7.1 A liquid seal coat, having following specifications should be applied immediately after laying the carpet and rolled to achieve maximum compaction. seal coats are of two types,

1) Type A: liquid seal coat for high rain fall areas, comprising an application of layer of bituminous binder followed by a cover of stone chippings, and lightly rolled.

The quantities of ingredients are as given below
2) Type B: premix seal coat for low rain fall areas comprising of a thin premixed fine grit or coarse sand. The quantities of ingredients are as given below

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity required per 100 m² of seal coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quantity of binder in terms of straight run bitumen 80/100 grade</td>
<td>98.0 kg</td>
</tr>
<tr>
<td>2. Stone chipping (6 mm size all passing through 10 mm sieve and retained on 2.36 mm sieve)</td>
<td>0.9 m³</td>
</tr>
</tbody>
</table>
Notes:

1. The combined compacted thickness of asphalt carpet and seal coat shall be minimum 62mm. The combined compacted thickness of two layers of asphalt carpet shall be minimum 50mm.
2. Contractor to procure asphalt 80/100 grade from HPCL only.

<table>
<thead>
<tr>
<th></th>
<th>Quantity required per 100 m² of seal coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Quantity of binder in terms of straight run bitumen 80/100 grade</td>
<td>68.0 kg</td>
</tr>
<tr>
<td>2. Stone chipping (passing through 1.7 mm sieve and retained on 1.18 mm sieve)</td>
<td>0.6 m³</td>
</tr>
</tbody>
</table>
STANDARD SPECIFICATIONS FOR
PLAIN & REINFORCED CEMENT CONCRETE
SPECIFICATIONS FOR PLAIN AND REINFORCED CEMENT CONCRETE

1.0 SCOPE

This Specification establishes the materials, mixing, placing, curing etc. of all types of cast-in-situ concrete used for various civil works as a part of construction of new depot facilities at talegaon project. Any special requirements as shown or noted on the drawings shall supersede over the provisions of this specifications.

1.1 Reference codes

Apart from this specification, construction of plain and reinforced concrete works shall be accordance with the Indian Standard Code of Practice for “Plain and Reinforced Concrete” IS : 456 and other relevant codes mentioned therein.

1.2 In case of conflict between the clauses mentioned in this specifications and those in the Indian Standard this specification shall govern.

2.0 Materials

2.1 Material for concrete viz cement, stand, coarse aggregate, water and Reinforcement steel shall be as described in the tender specification.
3.0 GRADES OF CONCRETE

Unless otherwise noted on drawings, or called for in the schedule of rates, the grade of RCC shall generally be as per Table-1.

<table>
<thead>
<tr>
<th>GRADE DESIGNATION</th>
<th>CHARACTERISTICS COMPRESSIVE STRENGTH OF 15 CM CUBE AT 28 DAYS (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M20</td>
<td>20</td>
</tr>
<tr>
<td>M 25</td>
<td>25</td>
</tr>
</tbody>
</table>

The characteristic strength is defined as the strength of material below which not more than five (5) percent of the test results are expected to fall.
4.0 TYPE OF CONCRETE MIX

4.1 Unless otherwise noted on drawings or given in Schedules of rates, all lean and reinforced concretes shall be nominal mix and design mix types respectively.

4.2 Nominal Mix Concrete

This concrete shall be made (without preliminary tests) by adopting nominal concrete mix with proportions of materials as specified in Table-1A.
### TABLE – 1A

<table>
<thead>
<tr>
<th>PROPORTIONS FOR NOMINAL MIX CONCRETE</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal mix of concrete (by Volume)</td>
<td>Quantity of water per 50 Kg of cement (max) Liters</td>
</tr>
<tr>
<td>1:5:10</td>
<td>60</td>
</tr>
<tr>
<td>1:4:8</td>
<td>45</td>
</tr>
<tr>
<td>1:3:6</td>
<td>34</td>
</tr>
</tbody>
</table>

**Notes:**

1. The proportions of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used.

2. The cement content of the mix shall be proportionately increased if the quantity of water in a mix has to be increased to overcome the difficulties of placement and compaction so that the water cement ratio as specified is not exceeded.

### 4.4 Design Mix Concrete
The mix shall be designed to produce the grade of concrete having the required workability and characteristic strength not less than appropriate values given in Table-1.

As long as the quality of material does not change, a mix design done earlier shall be considered adequate for latter work. However in case the quality of material changes, the Engineer-in-Charge may charge may ask for a new design mix.

While designing the mix, the durability requirement as given in IS: 456 and this specification shall also be taken into account.

5.0 CONCRETE MIX PROPORTIONING

Proportioning as used in this specification shall mean the process of determining the proportion of the various ingredients to be used to produce concrete of the required strength, workability, durability and other properties.

The Engineer-in-Charge shall verify the strength of the concrete mix, before giving his sanction of its use. However this does not absolve the Contractor of his responsibility as regards achieving the prescribed strength of the mix. If during the execution of the work, cube test show lower strengths than required The Engineer-in-Charge shall order fresh trial mixes to be made by the Contractor. No claim to alter the rates of concrete work shall be entertained due to such changes in mix variations. Any variation in cement consumption shall be taken in to consideration for material reconciliation. Preliminary mix design shall be established well ahead of start of work. The design mix shall be conforming to the guidelines of IS:
10262.

5.1 **Maximum Density**

Suitable proportion of sand and the different sizes of coarse aggregates for each grades of concrete shall be selected to give as nearly as practicable the maximum density. This shall be determined by mathematical means, laboratory test field trails and suitable changes in aggregate gradation. The contractor shall submit to the Engineer-in-Charge at least three sets of mix design and corresponding test results after varying the mix proportion and/or grading of aggregate so as to establish the maximum density of any particular grade of concrete.

5.2 **Water-Cement Ratio**

Once a mix, including its water cement ratio, has been determined and approved for use by the Engineer-in-Charge that water cement ratio shall be maintained. The Contractor shall determine the water content of the aggregates frequently as the work progresses and the amount of mixing water shall be adjusted so as to maintain the approved water-cement ratio. Maximum water cement ratio shall never exceed the values given in IS: 456 and IS:4651 for various exposures and sulphate attack conditions from durability considerations.

5.3 **Consistency**

The concrete shall have a consistency such that it shall be workable in the required position and when properly vibrated it flows around reinforcing steel, all embedded fixtures, etc.

5.4 **Workability**
5.4.1 The concrete mix proportion shall be such that the concrete is of adequate workability for the placing condition and can be properly compacted with the means available. Where adequate workability is difficult to obtain at maximum permissible water-cement ratio, increased cement shall also be alternatively considered while designing the mix proportions.

5.4.2 The suggested ranges of values of workability of concrete measured in accordance with IS: 1199 are indicated in Table-2 below. However the actual values to be followed shall be established depending on aggregate sizing, mix proportions, placing conditions etc. and shall be got approved by the Engineer-in-Charge.

<table>
<thead>
<tr>
<th>Placing Conditions</th>
<th>Degree of Workability</th>
<th>Values of Workability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concerting of shallow sections with vibration</td>
<td>Very Low</td>
<td>20-10 seconds vee-bee time or 0.75-0.80 compacting factor</td>
</tr>
<tr>
<td>Concreting of lightly reinforced sections with vibration</td>
<td>Low</td>
<td>10-5 seconds vee-bee time or 0.80-0.85 compacting factor</td>
</tr>
<tr>
<td>Heavily reinforced section with vibration</td>
<td>Medium</td>
<td>5-2 seconds vee-bee time or 0.89-0.92 compacting factor or 25-75 mm slump for 20 mm aggregate</td>
</tr>
</tbody>
</table>
5.5 Durability

For achieving sufficiently durable concrete, strong, dense aggregate, low water-cement ratio and adequate cement content shall always be used. Workability of concrete shall be such that the concrete can be completely compacted with the means available. Leak-proof formwork shall be used so as to ensure no loss of cement-slurry during pouring and compaction. Cover to reinforcement shall be uniform and as shown in drawings. Concrete mix design shall always take into account the type of cement, minimum cement content irrespective of the type of cement and maximum water-cement ratio conforming to the exposure conditions as given in Table -2A.

**Table - 2A**

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Type of Cement</th>
<th>Plain Concrete</th>
<th>Reinforced Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum cement content (Kg./m3)</td>
<td>Maximum water cement ratio</td>
</tr>
<tr>
<td>Moderate</td>
<td>OPC*/ PPC*/ PSC*/</td>
<td>240</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Note 2:

* OPC - Ordinary low heat Portland Cement.
* PPC - Portland Pozzolana Cement
* PSC - Portland Slag Cement

6.0 BATCHING

6.1 In proportioning concrete during mix design, the quantity of both cement and aggregate shall be determined by mass. Where the mass of cement is determined on the basis of mass of cement per bag, a reasonable number of bags shall be weighed periodically to check the net mass. Where the cement is weighed at site and not in bags, it shall be weighed separately from the aggregates. Water shall be either measured by volume in calibrated tanks or mass; Based on the results from Design Mix, Volume batching shall be adopted and same shall be accounted for in the design. All measuring equipment shall be mentioned in a clean serviceable condition, and their accuracy periodically checked.

6.2 Except where it can be shown to the satisfaction of the Engineer-in-Charge that supply of properly graded aggregate of uniform quality can be maintained over the period of work, the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in the right proportion when required, different sizes being stacked in separate stock piles. The grading of coarse and fine aggregates shall be checked frequently, the frequency for a given job being determined by the Engineer-in-Charge to ensure that the approved grading is maintained.

6.3 The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents in both fine and coarse aggregates. For the determination of moisture content in the aggregates IS: 2386 (Part-III) may be referred to. To allow for the variation in mass of aggregates to variation in their moisture content, suitable adjustments in the mass of aggregate shall also be made. In the absence of exact data, only in the case of nominal mixes, the amount of surface water may be estimated.
from the values given in Table-3.

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>Approximate quantity of surface water Values of Workability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent by mass</td>
</tr>
<tr>
<td>Very wet sand</td>
<td>7.5</td>
</tr>
<tr>
<td>Moderately wet sand</td>
<td>5.0</td>
</tr>
<tr>
<td>Moist sand</td>
<td>2.5</td>
</tr>
<tr>
<td>Moist Gravel or Crushed Rock</td>
<td>1.25-2.5</td>
</tr>
</tbody>
</table>

6.4 No substitutions in materials used in the work or alteration on the established proportions, except as permitted in 6.3 shall be made without additional tests to show that the quality and strength of concrete are satisfactory. In case the contractor proposes any change in the already approved mix design, fresh mix design with supportive laboratory tests shall be submitted to the Engineer-in-Charge and his approval has to be obtained prior to using the revised mix proportion in the works. However such proposals for revision shall only be entertained in case of successive
failure of test cubes to achieve the required strength or any other unforeseen event.

7.0 CONCRETE MIXING

7.1 The mixing of concrete shall be strictly carried out in an approved type of mechanical concrete mixer. The mixing shall be continued until there is a uniform distribution of the material and the mass is uniform in colour and consistency. If there is segregation, after unloading from the mixer, the concrete shall be remixed.

7.2 Mixer

7.2.1 Mixer shall comply with IS: 1791 and shall be maintained in satisfactory operating conditions. Mixer drum shall be kept free of hardened concrete and blades shall be replaced when worn down more than ten percent (10%) of their depth. Should any mixer at any time produce unsatisfactory results, leak mortar or cause waste of materials, its use shall be promptly discontinued until it is repaired.

7.2.2 Mixing Time

Mixing time shall be as indicated in the following table. Excessive mixing requiring Addition of water shall not be permitted. Time shall start when all solid materials are poured in the revolving mixer drum, provided that all of the mixing water shall be introduced before one-fourth of the mixing time has elapsed. The Engineer-in-Charge may, however direct a change in the mixing time, if he considers such a change necessary.
### Capacity of Mixer vs Minimum Mixing Time

<table>
<thead>
<tr>
<th>Capacity of Mixer</th>
<th>Minimum Mixing Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 m³ or less</td>
<td>1 ½ minutes</td>
</tr>
<tr>
<td>3 m³</td>
<td>2 ½ minutes</td>
</tr>
<tr>
<td>5 m³</td>
<td>3 minutes</td>
</tr>
</tbody>
</table>

All records and charts for the batching and mixing operation shall be prepared and maintained by the Contractor as per the instructions of the Engineer-in-Charge.

#### 7.3 Hand Mixing

Hand Mixing of concrete shall not be permitted. However for lean concrete, this may be permitted by the Engineer-in-Charge as a special case. Ten percent (10%) extra cement shall have to be added to the normal mix when mix by hand. It shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency No extra payment shall be made to the Contractor for mixing by hand or for using extra cement due to hand mixing. However extra cement consumed shall be considered for reconciliation purposes where such concerting is allowed by the Engineer-in-Charge.

#### 8.0 TRANSPORTATION, PLACING AND COMPACTION

8.1 General

The entire concrete placing program including transportation arrangements, deployment of requirement, lay out proposed procedures and methods shall be submitted to the Engineer-in-Charge 24 hours prior to concreting, for approval. no concreting shall be placed until his approval has been
received. Approval of the Engineer-in-Charge for pouring concrete shall be taken as ‘conveyed’, when the concrete pour card is signed by him.

8.1.1 Vibrators

8.1.1.1) Concrete shall be compacted with mechanical vibrating equipment supplemented, if necessary to obtain consolidation, by hand spreading, rodding and tamping. The vibrators shall be of immersion type with operational frequency ranging between 8,000 and 12,000 vibrations per minute. All vibrators shall comply with IS: 2505. Screed board concrete vibrators or concreting vibrating tables or form vibrators conforming to IS: 2506, 2514 and 4656, respectively may also be used where specifically required and directed by Engineer-in-Charge.

8.1.1.2) Immersion type vibrators shall be inserted in a vertical position at intervals of about 600 mm depending upon the mix, the equipment used, and experience on work. The vibrator shall be withdrawn slowly. The spacing shall provide some overlapping of the area vibrated at each insertion. In no case shall vibrators be used to transport concrete inside the forms. Over vibration or under vibration shall not be permitted as both are harmful. Hand tamping in some cases may be allowed subject to the approval of the Engineer-in-Charge.

8.1.1.3) In placing concrete in layers which are advancing horizontally as the work progress, great care shall be exercised to ensure adequate vibration, bonding and molding of the concrete between the succeeding batches.

8.1.1.4) The vibration shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.
8.1.1.5) Care shall be taken to prevent contact of vibrators against all embedded reinforcing steel or inserts. Vibrators shall not be allowed to come in contact with forms.

8.1.1.6) The use of form vibrator shall not be permitted for compaction of in-situ concrete without specific authorization of the Engineer-in-Charge.

8.1.1.7) The use of surface vibrators of screed board type shall not be permitted for consolidation of concrete under ordinary conditions. However, for thin slabs (of thickness less than 200mm) surface vibration by such vibrators may be permitted, upon approval of the Engineer-in-Charge.

8.1.1.8) Wherever vibration has to be applied externally, the design of form work and the disposition of vibrators shall be carefully planned to ensure efficient compaction and to avoid surface blemishes.

8.2 Transportation

8.2.1 All concrete shall be conveyed from the mixer to the place of final deposit as rapidly as possible in suitable buckets, dumpers, containers or conveyors which shall be mortar leak tight. Care shall be taken to prevent the segregation or loss of the ingredients and maintaining the required workability.

8.2.2 During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted. All equipment used for transporting and placing of concrete shall be maintained in clean condition. All buckets, hoppers, chutes, dumpers
and other equipment shall be thoroughly cleaned after each use.

8.3 **Placing and Compaction**

8.3.1 Before placing concrete, all soil surfaces upon which or against which concrete is to be placed shall be well compacted and free from standing water, mud or debris. Soft or yielding soil shall be removed and replaced, with lean concrete with selected soils/sand and compacted to the density as directed by Engineer-in-Charge. The surface of absorptive soil (against which concrete is to be placed) shall be moistened thoroughly so that moisture is not drawn from the freshly placed concrete. **Alcathene sheet must be placed and spread before placement of concrete.**

8.3.2 Concrete shall not be placed until the formwork, the placement of reinforcing steel, embedded parts; pockets etc. have been inspected and approved by the Engineer-in-Charge. Any accumulated water on the surface of the bedding layer shall be removed by suitable means before start of placement No. concrete shall be placed on a water covered surface.

8.3.3 Concrete shall be discharged by vertical drop only and the drop height shall not normally exceed 1.5 meter throughout all stages of delivery until the concrete comes to rest in forms. For continuous concrete operation windows of suitable size shall be kept in the formwork or chutes shall be used to avoid segregation of concrete.

8.3.4 Concrete shall be deposited as near as practicable in its final position to avoid rehandling. Concrete shall be placed in successive horizontal layers the bucket loads, or other units of deposits shall be placed progressively along the face of the layer with such over-lap as will facilitate spreading the
layer of uniform depth and texture with a minimum of hand shoveling. Any tendency to segregation shall be corrected by shoveling coarse aggregates into mortar rather than mortar on the coarse aggregates. Such a tendency for segregation shall be corrected by redesign of mix, change in process or other means, as directed by the Engineer-in-Charge.

8.3.5 All struts, stays and braces (serving temporarily to hold the forms in correct shape and alignment pending the placing of concrete at their locations) shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These shall not be buried in the concrete. Concrete shall be thoroughly compacted with vibrators and fully worked around the reinforcement, embedded fixtures and into corners of form work before setting commences and shall not be subsequently disturbed. Method of placing shall be such as to preclude segregation. The formation of stone-pockets or mortars bondage in corners and against face forms shall not be permitted should these occur, they shall be dug out, reformed and refilled to sufficient depth and shape for thorough bonding as directed by the Engineer-in-Charge. Care shall be taken to avoid displacement of reinforcement and embedded inserts or movement of formwork.

8.3.6 Unless otherwise approved concrete shall be placed in single operation to the full thickness of foundation rafts, slabs, beams and similar members. Concrete shall be placed continuously until completion of the part of the work between approved construction joints or as directed by the Engineer-in-Charge.

8.3.7 The method of placing and compaction employed in any particular section of the work shall be to the entire satisfaction of the Engineer-in-Charge.

8.3.8 During hot weather (atmospheric temperature above 40 degree Celsius) or
cold weather (atmospheric temperature below 5 degree Celsius), the concreting shall be done as per the procedure set out in IS: 7861.

8.3.9 Concrete that has set standing and becomes stiffened shall not be used in the work.

8.4 Items embedded in Concrete

8.4.1 Concreting shall not be started unless the electrical conduits, pipes, fixtures etc. wherever required are laid by the concerned agency. The Contractor shall afford all the facilities and maintain co-ordination of work with other agencies engaged in electrical and such other work as directed by the Engineer-in-Charge.

8.4.2 Before concreting, the Contractor shall provide, fabricate and lay in proper position all metal inserts anchor bolts, pipes etc. (which may be required to be embedded in concrete members) as per relevant drawings and directions of Engineer-in-Charge.

8.4.3 All embedment inserts etc. shall be fully held and secured in their respective positions by the concerned agencies to the entire satisfaction of Engineer-in-Charge so as to avoid any dislocation or displacement during the concreting to maintain these embedment /inserts in their exact location.

9.0 CONSTRUCTION JOINTS

9.1 Construction joints shall be provided in position as shown or described on the drawings or as directed by the Engineer-in-Charge. Such joints shall be
kept to the minimum. These shall be straight and at right angles to the
direction of main reinforcement.

9.2 When stopping the concrete on a vertical plane in slabs and beams, an
approved stop board shall be placed with necessary slots for reinforcement
bars. The construction joint shall be keyed by providing a triangular or
trapezoidal fillet nailed on the stop board. Inclined joint shall not be
permitted. Any concrete flowing through the joints of stop board shall be
removed soon after the initial set. When concrete is stopped on a horizontal
plane, the surface shall be roughened and cleaned after the initial set and a
triangular or trapezoidal groove shall be provided for keying with the new
concrete later.

9.3 When the work has to be resumed on a surface which has hardened, such
surface shall be cleared of any foreign materials and roughened to expose
the tips of the coarse aggregate. It shall then be swept clean and thoroughly
washed and wetted before any new concrete is poured. It shall then be
swept clean and concrete sticking to the exposed reinforcing rods in and
around such joints shall be thoroughly removed. The reinforcement shall be
wire brushed and washed just before pouring any cement slurry or mortar.
For vertical joints neat cement slurry shall be applied on the surface before
it is dry. For horizontal joints the surface shall be covered with a layer of
mortar about 10 to 15 mm thick composed of cement and sand in the same
ratio as the cement and sand in concrete mix. This layer of cement slurry or
mortar shall be freshly mixed and applied immediately before placing new
concrete.

9.4 Where the concrete has not fully hardened, all laitance shall be removed by
scrubbing the wet surface with wire or bristle brushes, care being taken to
avoid dislodgement of particles of aggregates. This surface shall be
thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry. On this surface, layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work, particular attention being paid to corners and close spots; work there after shall proceed in normal way.

9.6 SEPERATION OF JOINT

Separation joint shall be obtained by using an approved alkathene sheet stuck on the surface against which concrete shall be placed. Adequate care shall be taken to cause no damage to the sheet.

9.7 PROTECTION OF FRESHLY LAID CONCRETE.

Newly placed concrete shall be protected by approved means from rain, sun and wind. Concrete placed below the ground level shall be protected from falling earth during and after placing. Surface shall be kept free from contact with such ground or with water draining from such ground during placing of concrete for a period of at least 3 days, unless otherwise directed by the Engineer – in- Charge.

The ground water around newly poured concrete shall be kept to an approved level by pumping or other approved means of drainage and adequate steps shall be taken to prevent floatation and flooding. Steps shall be taken to protect immature concrete from damage by debris, loading, vibrations, abrasion, mixing with deleterious materials that may in the opinion of the Engineer – in –Charge impair the strength and/or durability of the concrete.

10.0 CURING
Concrete shall be cured by keeping it continuously moist wet for the specified period of time to ensure complete hydration of cement and its hardening; Curing shall be started after 8 hrs. of placement of concrete, and in hot weather after 4hrs. The water used for curing shall be of the same quality as that used for making of concrete.

Curing shall be assured by use of an ample water supply under pressure in pipes with all necessary appliances such as hose, sprinkles etc. A layer of sacking, canvas, Hessian, of other approved materials which will hold moisture for long periods and prevent loss of moisture of the concrete shall be used as covering. Type of covering which would stain, disfigure, or damage the concrete, during and after the curing period shall not been used. Only approved covering shall be used for curing.

Exposed surfaces of concrete shall be maintained continuously in damp or wet conditions for at least the 1st 7/10 days after placing of concrete.

The Contractors shall have all equipment & materials required for curing on hand & ready to use before concrete is placed.

For curing the concrete in pavement floors, flat roofs or other level surfaces, the ponding method of curing is preferred after the expiry of first 24hrs during which (i.e. 1st 24 hrs) the concrete shall be cured by use of wet sacking, canvas Hessian etc. The minimum water depth of 25mm for ponding shall be maintained. The ponded area shall be kept contiously filled with water & leaks, if any shall be promptly repaired. Areas cured by ponding method shall be cleared of all debris and foreign materials after curing is over.
11.0 **FIELD TESTS**

11.1 Grading Test

Grading Test on fine and coarse aggregates shall be carried out as per IS: 2386 at intervals specified by the Engineer – in – Charges.

The mandatory tests and their frequencies shall be done on sand and stone aggregates as given table – 4.

11.2 Slump Test of concrete

At least one slump test shall be made for every compressive strength test carried out. More frequent tests shall be made if there is a distinct change in working conditions or if required required by the Engineer-in-Charge.

11.3 Strength Test of Concrete

11.3.1 Samples from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS: 516.

11.3.2 In order to get a relatively quickest idea of the quality of concrete, optional test on beams for modulus of rupture at 72+2 hours or at 7 days, or compressive strength at 7 days in addition to 28 days compressive strength tests. For this purpose the values given in table – 5 may be taken for general guidance in the case of concrete made with ordinary Portland cement. In all cases, the 28 days compressive strength specified in Table –I shall alone be the criterion of acceptance or rejection of the concrete from strength consideration If however from test carried out in a particular work over a reasonably long period, it has been established to the satisfaction of
Engineer-in-Charge that a suitable ratio between 28 days compressive strength and the modulus of rupture at 72 ± 2 hours or compressive strength at 7 days may be accepted, the Engineer-in-Charge may suitably relax the frequency of 28 days compressive strength specified in clause 11.3.4, provided the expected strength values at the specified early age are consistently met. However, set of test cubes for 28 days strength test shall always be taken and maintained to cater to any contingencies in the event of failure of 7 – days strength.

### TABLE – 5

**OPTIONAL TEST REQUIREMENT OF CONCRETE**

<table>
<thead>
<tr>
<th>Grade of Concrete</th>
<th>Compressive strength on 15 cm cubes minimum at 7 days (N/mm²)</th>
<th>Modulus of Rupture by Beam Test, at minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 25</td>
<td>17.0</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.4</td>
</tr>
</tbody>
</table>

#### 11.3.3 Procedure

A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested, that is a sampling should be spread over the entire period of concreting and cover all mixing units.

#### 11.3.4 Frequency of sampling
The minimum Frequency of sampling of concrete for each grade shall be in accordance with the following:

<table>
<thead>
<tr>
<th>Quantity of concrete in the work in m³</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>1</td>
</tr>
<tr>
<td>6-15</td>
<td>2</td>
</tr>
<tr>
<td>16-30</td>
<td>3</td>
</tr>
<tr>
<td>31-50</td>
<td>4</td>
</tr>
<tr>
<td>51 &amp; above</td>
<td>4 plus one additional sample for each additional 50m³ or part thereof</td>
</tr>
</tbody>
</table>

**NOTE:** At least one sample shall be taken from the shift.

11.3.5 Test Specimen

Three Test Specimen shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the formwork, or to determine the duration of curing, or to check the testing error. The specimens shall be tested as described in IS: 516.

11.3.6 Test strength of Sample

The Test strength of Sample shall be the average of the strength of three specimens. The individual variation should not be more than ±15 percent of the average.
11.3.7 Standard deviation

i] Standard deviation based on test results:

a] Number of test results: The total number of test results required to constitute an acceptable record for calculation of standard deviation shall not less than 30. Attempts should be made to obtain the 30 test results as early as possible, when a mix is used for the first time.

b] Standard deviation to be brought up to date: The calculation of the standard shall be brought up to date after every change of mix design and at least once a month.

ii] Determination of Standard Deviation:

a] Concrete of each grade shall be analyzed separately to determine its standard deviation.

b] The Standard Deviation of concrete of a given grade shall be calculated using the following formula from the results of individual tests of concrete of that grade obtained as specified in 11.3.6

ESTIMATED STANDARD DEVIATION (S) =\((\sum \Delta^2)/(n-1))^{1/2}\)

\(\Delta\)- deviation of individual test strength from average strength of n samples

n- number of sample test results

C] When significant changes are made in the production of concrete batches (for example changes in the materials used, mix design,
equipment or technical control), the standard deviation value shall be separately calculated for such batches of concrete.

iii) Assumed Standard Deviation: Where sufficient test result for a particular grade of concrete are not available, the value of standard deviation given Table-6 may be assumed.

<table>
<thead>
<tr>
<th>Grade of concrete</th>
<th>Assumed Standard Deviation(N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M25</td>
<td>5.3</td>
</tr>
</tbody>
</table>

However when adequate past records for a similar grade exist and justify to the Engineer-in-Charge, a value of standard deviation different from that shown in Table-6, it shall be permissible to use that value.

11.3.8 Acceptance Criteria

11.3.8.1 The concrete shall be deemed to comply with the strength requirements if:

a] every sample has a test strength not less than the characteristic
value;

b] The strength of one or more samples though less than the characteristic value, is in each case not less than the greater of:

(i) the characteristic strength minus 1.35 times the standard deviation;

and

(ii) 0.80 times the characteristics strength; and the average strength of all the samples is not less than the characteristics strength plus 
\[1.65 \times \left(1.65/(n)^{1/2}\right)\] S.D.

11.3.8.2 After completion of 28 days testing and receipt of test results, the entire RCC work shall be inspected by a HPCL approved Third Party Laboratory/ Expert. The Third Party Lab/ expert shall carry out an independent assessment of the RCC work and may carry out any testing activities for assessing the quality/ strength characteristics and give a certificate for same.

11.3.8.3 Pursuant to satisfactory completion of activities listed in Cl.11.3.8.1 and 11.3.8.2, the RCC work shall be accepted by HPCL Engineer-in-Charge and measurement & Payment for the work shall be effected. Any portion of the RCC work that does not satisfy the requirements spelt out in Cl. 11.3.8.1 and 11.3.8.2 shall not be measured and no payment shall be made for same.

11.3.8.4 It shall therefore be the sole responsibility of the Contractor to ensure that all the sample strength test results and any other tests required as per IS Code/Third party Inspection Laboratory/ expert are satisfactory with
respect to the particular grade of concrete.

11.3.8.5 Concrete of each grade shall be assessed separately.

11.3.8.6 Concrete shall be assessed daily for compliance.

11.3.8.7 Concrete is liable to be rejected if it is porous or honey-combed; its placing has been interrupted without providing a proper construction joint; the reinforcement has been displaced beyond the tolerances specified; or construction tolerance have not been met. However the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge.

12.0 INSPECTION OF STRUCTURES

12.1 Inspection

Immediately after stripping the formwork, all concrete shall be carefully inspected and defective work or small defects, if any, shall either be removed or made good before concrete has thoroughly hardened.

12.2 The Engineer-in-Charge shall be the final authority for interpreting the result of all tests and shall decide upon the acceptance or otherwise. The decision of the Engineer-in-Charge shall be final & binding on the contractor. Incase the result of the tests are unsatisfactory, the Engineer-in Charge may instruct the contractor to demolish and reconstruct the structure or part there of without any extra cost and time to the owner.

12 FINISHING OF CONCRETE
13.1 On striking the form work all surface defects such as bulges, ridges and honey-combing etc. observed shall be brought to the notice of the Engineer-in Charge. The Engineer-in Charge may, at his discretion allow rectification by necessary chipping and packing or grouting with concrete or cement mortar. However, if honey combing or sagging are of such extent as being undesirable, the Engineer-in Charge may reject the work totally and his decision shall be binding. No extra payment shall be made for rectifying these defects, demolishing & reconstructing the structure. However, quantity of cement actually used for this purpose may be considered for reconciliation of materials. All burrs and uneven faces shall be rubbed smooth with the help of carborundum stone.

The surface of non–shuttered faces shall be smoothened with a wooden float to give a finish similar to that of the rubbed down shuttered faces. Concealed concrete faces shall be left as from the formwork except that honey combed surface shall be made good as specified above. The top faces of slabs not intended to be covered shall be leveled & floated to a smooth finish to the rises or falls shown on the drawings or as directed. The floating shall not be executed to the extent of bring excess fine materials to the surfaces. The top faces of slabs intended to be covered with screed, granolithic or similar faces shall be left with a rough finish.

13.2 **Repair & replacement of unsatisfactory concrete.**

13.2.1 Repair shall be made as soon as possible after the forms are removed and before the concrete becomes too hard with prior permission from the Engineer-in Charge, in writing. Stone pockets, segregations patches and damaged areas shall be chipped out and the edges undercut slightly to form a key. All loose materials shall be washed out before patching. No excess water shall be left in the cavity, but the concrete shall be damp. A good
bond between the patch & parent concrete shall be obtain by sprinkling dry cement on the wet surfaces or by throwing mortar with force on to the wetted concrete, or by brush and a coat of thick cement grout of about 1:1(Cement: Sand) just before applying the patching materials. Before this has dried the remainder of the patch shall be filled with mortar or with concrete depending on the extent of the repair.

13.2.2 Cement concrete/mortar used in repair of exposed surfaces shall be made with cement from the same source as that used in concrete and blended with sufficient amount of white Portland cement to produce the same color as in the adjoining concrete. The proportions of ingredients shall be same as those used in parent concrete. The mortar shall be as dry as possible and well compacted into the cavity. All filling shall be tightly bonded to the concrete and shall be sound, free from shrinkage cracks after the filling has been cured and dried.

13.2.3 For larger repairs to hardened concrete, necessary formwork bearing tightly at the edges of the cavity shall be provided. Concrete shall be chipped out to a depth of at least 100mm and preferably 150mm. Mortar shall be scrubbed into all surfaces with a wire brush before placing the concrete. Damaged reinforcement shall be adequately spliced with new steel so as maintain the original strength. Additional reinforcement, if required in the patch, shall be provided as per the instructions of Engineer-in Charge.

13.2.4 In case in the opinion of the Engineer-in Charge defects in the concrete is excessive or beyond repair, the contractor shall be either redo the structure or take other remedial measures as instructed by the Engineer-in Charge. The decision of the Engineer-in Charge shall be final and binding to all in this respect.
13.2.5 All repair works due to non-conformance or non-adherence to specification, if allowed by the Engineer-in Charge, shall be carried out free of cost to the owner.

13.3 Curing of Patched Work

Immediately after patching is completed, the patched area shall be covered with an approved non-staining water saturated material, which shall be kept wet and protected against sun and wind for a period of 12 hrs. Thereafter, the patched area shall be kept continuously wet by a fine spray or sprinkling for not less than 10 days.

14.0 FORM WORK

14.1 General

14.1.1 Forms for concrete shall be of plywood conforming to IS: 6461 or steel or as directed by the Engineer-in Charge and shall give smooth and even surface after removal thereof.

14.1.2 If the Engineer-in Charge desires it, the Contractor shall prepare, before commencement of actual work, design and drawings for formwork and get them approved by the Engineer-in Charge.

14.1.3 Form work and its supports shall maintain their correct position and be to correct shape and profile so that the final concrete structure is within the limits of dimensional tolerances specified below, unless required otherwise, for functional/aesthetic reasons. The decision of the Engineer-in Charge shall be final and binding in this regard.
14.1.4 **Form Requirement:**

The formwork shall be true, rigid and adequately braced both horizontally as well as diagonally. The form shall have smooth and even surface and be sufficiently strong to carry, without deformation, the deed, and weight of the green concrete, working load, wind load, and also the side pressure exerted by the green concrete. As far as practicable clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum nos. of nails shall be used. Projected part of nail shall oct bent or twisted for easy withdrawal.

14.1.5 Where through tie rods are required to be put to hold the formwork and maintain accurate dimension, they shall always be inserted through a precast concrete block (of same mix proportion as is to be used for concreting) with a through hole of bigger diameter. The Precast block shall tightly fit against in inner faces of formwork. The holes left after the withdrawal of tie rods shall be fully grouted with cement-sand mortar of same proportion as that used for concrete. However use of such precast block shall in no case impair the desirable appearance or durability of the structure. No such tie rods shall be used in any liquid retaining or basement structure.

14.1.6 Tie wires shall be permitted only upon approval of the Engineer-in-Charge and shall be cut off flush with the face of the concrete or counter sunk, filled and finished in the manner specified in clause for **Finishing of Concrete**.

14.1.7 Form joint shall not permit any leakage. The formwork shall be strong enough to withstand the effect of vibration practically without any
deflection, bulging, distortion or losing or of its components

14.1.7 Forms for beams and slabs (span more than 6.0m) shall have camber of 1 in 500 so as to offset the deflection and assumed correct shape and line after deposition of concrete. For cantilevers, the camber at free end shall be $\frac{1}{100}$ of the projected length. Where architectural, consideration and adjunctive work are critical, smaller form cambers shall be adopted as decided by the Engineer-in-Charge.

14.2 Inspection of Forms

Temporary opening shall be provided at the base of column and wall forms and other places necessary to vacillate cleaning and inspection. Before concrete is placed, all forms shall be carefully inspected to ensure that they are properly placed, sufficiently rigid and tight, thoroughly cleaned, properly treated and free from foreign material. The complete form work shall be inspected and approved by the Engineer-in-Charge before the reinforcement bars are placed in position. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the work shall be stopped until the defects have been corrected as per the instructions of the Engineer-in-Charge.

14.3 Treatment of Forms

The surfaces of forms that would come in contact with concrete shall be well treated with approved non-staining release agents such as soft stop, oil, emulsions etc. Care shall be taken that such releasing agents are kept out of contact with the reinforcement.
14.4 Chamfers and Fillets

All corners and angles shall be formed with 45 degree molding to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise detailed or specified shall be 25 X 25 mm. For heavier work chamfers or fillets shall be 50 X 50 mm. Care shall be exercised to ensure accurate moldings. The diagonal face of the molding shall be planned or surfaced to the texture as the forms to which it is attached.

14.5 Reuse of forms

Before reuse, all forms shall be thoroughly scrapped, cleaned, examined and when necessary, repaired and retreated before resetting. Formwork shall not be reused, if declared unfit or un-serviceable by the Engineer-in-Charge.

14.6 Removal of Forms/Stripping Time

In the determination of time for removal of forms, consideration shall be given to the location and character of the structures, the weather and other conditions including the setting and curing of the concrete and material used in the mix.

Forms and their supports shall not be removed without the approval of the Engineer-in-Charge. The formwork shall be removed without shock and methods of form removal likely to cause over stressing or damage to the concrete, shall not be adopted. Support shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight.
In normal circumstances when average air temperature exceeds 16 degree Celsius during the period under consideration after pouring of concrete and where ordinary Portland cement is used, forms may generally be removed after expiry of following periods.

(a) Walls, columns and vertical faces of all structural members: 24 to 48 hours as may be decided by the Engineer-in-Charge

(b) Slabs (props left under): 3 days

(c) Beams Sophist (props left under): 7 days

(d) Removal of props under slabs:
   - Spanning up to 4.5m: 7 days
   - Spanning over 4.5m: 24 days

(e) Removal of props under beams and arches:
   - Spanning up to 6m: 14 days
   - Spanning over 6m and up to 9m: 21 days
   - Spanning over 9m: 28 days

(f) Cantilever Construction:
   Formwork shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength (minimum 14 days)
Notes:

1. For rapid hardening cement, 3/7 of the above mentioned periods shall be considered subject to a minimum of 24 hours.
2. For other cements, the stripping time recommended for ordinary Portland cement shall be suitably modified as per the instructions of the Engineer-in-Charge.
3. The number of props left under, their sizes, supporting arrangement, and disposition shall be such as to be able to safely carry the full dead of the slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.
4. Where the shape of the element is such that the formwork has re-entrant angles, the formwork shall be removed as soon as possible after the concrete has set, to avoid shrinking cracking occurring due to the restraint imposed.

15 EXPOSED / ARCHITECTURAL CONCRETE WORK.

15.1 Form Work.

Other things remaining same as per clause 14.0, formwork shall be of high quality. Care shall be taken to arrange the forms so that the joints between forms correspond with the pattern indicated in the drawing. The forms shall be butting with each other in straight lines, the corners of the boards being truly at right angles. The joints shall be between the forms shall cross in the two directions at right angles. The size of forms shall be so selected as to exactly match with patterns of forms impression on the concrete face indicated in the drawing. Maximum care shall be taken to make the form work watertight. Burnt oil shall not be used for treatment of forms. The contactor shall be permitted reuse of forms brought new on the work for
exposed concrete work as specified below.

Such reuses shall be permitted only if forms are properly cared for stored, prepared and treated after each use.

Such reuses shall be permitted only if forms are properly cared for, stored. Repaired and treated after each use.

a] Plywood Forms 6 Reuses (Max.)

b] Steel Forms 10 Reuses (Max.)

The Engineer – in – Charge may, at his absolute discretion, order removal of any forms considered unfit for use in the work irrespective of the number of uses specified above.

15.2 Finishing
Repairing to exposed concrete work shall be avoided. Rendering and plastering shall not be done. Minor repairing, if unavoidable shall be done as specified in Finishing of Concrete with the written permission of the Engineer – in – Charge.

16 REINFORCEMENT

16.1 Reinforcement shall be cut, bent to shape and dimension as shown in the bar bending schedule/structural parts shall be supplied to the contractor. However, in cases where bar bending schedule is not provided, the Contractor shall develop the same at no extra cost to the Owner and get it reviewed by the Engineer – in – Charge. The Contractor shall check the bar bending schedule (issued by the Owner) prior to fabrication and satisfy
himself about the correctness of the same.

16.2 Straightening, Cutting and Bending

Procedure for cutting and bending shall be as given in IS: 2502. In case bars are supplied in coils, they shall be smoothly straightened without any kinks.

Bars shall be bent in a slow and regular movement to avoid fractures. Bars which develop cracks or splits after bending shall be rejected. A second bending of reinforcement bars shall be avoided but when reinforcement bars are bent aside at construction joints and afterwards bent back into their original positions, care should be taken to ensure that at no time is radius of the bend less than 4 times bar diameter for plain mild steel or 6 times bar diameter for high strength deformed bars. Care shall also be taken when bending back bars to ensure that concrete around the bars is not damaged. All bars shall be properly tagged for easy identification.

Placing and Fixing

All reinforcement shall be cleaned to ensure freedom from loose mill scale, loose rust, oil, grease or any other harmful material before placing them in position. Reinforcement shall not be surrounded by concrete unless it is free from all such materials.

All reinforcement shall be fixed in the correct position and shall be properly supported to ensure that displacement will not occur when the concrete is placed and compacted.

The reinforcement shall be tied at every intersection by two standards of 20 SWG black soft annealed binding wire. Crossing bars shall not be tack welded for assembly of reinforcement. The reinforcement bars shall be kept
in position by using the following methods:

a] In case of beam and slab construction, precast cover blocks (having the same cement sand contents as the concrete which shall be placed) of sizes 40 X 40 mm and thickness equal to the specified covers shall be placed firmly in between the bars and forms so as to secure and maintain the specified covers over the reinforcement.

When reinforcement bars are placed in two or more layers in beams, the vertical distance between the horizontal bars shall be maintained by introducing spacer bars at 1 to 1.2 m center to center.

b] Exposed portions of reinforcement bars shall not be subjected to Impact or rough handling and workmen will not be permitted to climb on extending bars until the concrete has attended sufficient strength so that no movement of the bars in the concrete is possible.

**Splicing / Overlapping**

Only bars of full length shall be used as shown in the drawings. But where this can not be done, overlapping of bars shall be done as directed by the Engineer-in-Charge. Where practicable, the overlapping bars shall not touch each other, but these shall be kept apart by 25 mm or 1.25 times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be tied with two strands of 20 SWG black soft annealed binding wire. The overlap shall be staggered for different bars and located at points along the span where neither shear nor bending moment is maximum.

16.3 Tolerance
Unless otherwise directed by the Engineer-in-Charge, reinforcement shall be placed within the following tolerance:

a] For effective depth 200mm or less  + 10 mm

b] For effective depth more than 200mm  + 15 mm

The cover shall in no case be reduced by more than one third of specified cover or 5mm, which ever is less.

16.4 Substitution
When indicated diameter of reinforcement bars is not available, the Contractor shall use other diameter of reinforcement bars on written approval of the Engineer-in-Charge.

16.5 Cover
Cover to reinforcement shall be as indicated on the drawings and in their absence as directed by the Engineer-in-Charge.

17.0. PAYMENTS

17.1 Plain and Reinforced Concrete

17.1.1 Payment for plain and reinforced Cement Concrete (cast - in - situ) shall be made on cubic mtrs. basis of the volume of the actual finished work done or as per approved constructions drawing, which ever is less and shall be inclusive of providing pockets, Openings, recesses of all sizes, chamfers, fillets, grooves, seperations/expansion/isolation/construction/movement joints, cement wash, curing by normal moist curing or using curing compounded. As directed by Engineer - in -Charge etc. The rates shall be
deemed to include complete cost of getting the respective mix designs approved, taking & testing concrete cubes and carrying out other tests including tests of various ingredients, as per specifications and as directed by Engineer - in –Charge.

17.1.2 No separate payment shall be made for any admixture / additive used by the contractor for accelerating or retarding the strength of concrete, or, for achieving specified workability / water tightness. The rate shall be coated shall be deemed to be inclusive of all costs related to any such admixture/additives

17.1.3 The rate shall however be exclusive of reinforcement, metal inserts, pipe sleeves, formwork, water stops, and any filler material in expansion / isolation joints.

17.1.4 In case the cubes strength shows higher results than those specified for the particular grade of the concrete, it shall not be placed in the higher grade nor shall the contractor be entitled for any extra payment on such account. If the Engineer-in-Charge instructs, the rejected concrete shall be dismantled at no extra cost to the owner and no payment or extension of time shall be granted for the concrete so rejected an the formwork and reinforcement used for the same. Cost of any material supplied by the owner free of cost shall be recovered from the contractor at double the prevailing market rate.

17.1.5 Deductions for opening, pockets etc. shall be as specified in relevant Indian Standard Codes.

17.2 **Form Work**
Unless otherwise specified, payment of formwork shall be on square meter basis of the actual area in contact with the concrete cast and the rate shall be inclusive of keeping the formwork for the full period as specified in the above clauses and removing the same after the period is over. No extra payment shall be made for providing scaffolding/staging/access/stairways/ladders etc.

The rate shall be inclusive of any provision to be made or kept in the formwork for providing dowels, inserts etc.

17.3 Reinforcement

17.3.1 Payment for high strength deformed steel bars shall be on the basis of weight in metric tons. The weight shall be derived from the sizes and corresponding unit weights given in handbook of Bureau of Indian Standard. Standard hook length, Chairs Spacers and bar and authorize labs only shall be included in the weight calculated. Binding wire shall not be weighed nor otherwise measured. Measurement for weight shall not include cutting allowance, etc.

17.3.2 Rate quoted for reinforcement shall include cost of supplying decoiling, straightening, cleaning, cutting, bending, placing, binding, welding, if required, and providing necessary over blocks of concrete.

17.4 Cement Wash

17.4.1 No payment shall be made for cement wash if any carried out by Contractor for finishing honey comb areas.
TECHNICAL SPECIFICATIONS
FOR BRICK MASONRY
TECHNICAL SPECIFICATIONS
FOR BRICK MASONRY

Common burnt clay building bricks having compressive strength up to 400 kg/cm² shall conform to IS: 1077-1976. Burnt clay bricks having compressive strength more than 400 kg/cm² shall conform to IS: 2180-1978. Bricks shall be hand or machine molded and free from cracks and flaws and nodules of free lime. Bricks of 9 cm height shall be provided with frog of 1 to 2 cm deep on one of its flat sides. No frog is required for 4 cm height bricks and extruded bricks.

CLASSIFICATION

Bricks shall be classified based on their compressive strength as given in table below:

<table>
<thead>
<tr>
<th>CLASS DESIGNATION</th>
<th>AVG. COMPRESSIVE STRENGTH NOT LESS THAN (KG/SQM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>175</td>
<td>175</td>
</tr>
</tbody>
</table>
Each class of brick shall be further divided into sub classes A and B based on tolerances and shape.

Sub class A bricks shall be smooth rectangular faces with sharp corners and uniform color.

Sub class B bricks may have slightly distorted and rounded edges.

The bricks of class designation 100 shall have smooth rectangular faces with sharp corners and emit clear ringing sound when struck. Tolerances on dimensions up to +/-3% shall be permitted. Dimension test to be carried out as per IS.
Bricks of class designation 75, 50 and 35 may be permitted to have slight distorted and rounded edges provided no difficulty shall arise on this account in laying of uniform courses. Tolerances on dimensions up to +/- 8% shall be permitted. Dimension test to be carried out as per IS.

**PHYSICAL REQUIREMENTS:**

Compressive Strength:

This shall conform to table given above. Compressive strength of any individual brick shall not fall below this minimum requirement by more than 20%.

Water Absorption:-

Shall not be more than 20% up to class 125 and not more than 15% for higher classes.

Efflorescence:-

The rating of efflorescence shall not be more than moderate up to class 125 and not more than slight for higher classes.
TESTING:-

The details of test shall be as per IS-3495-1976 Part I, II and III (Method of test of burnt clay building brick).

Part I: Determination of Compressive Strength

Part II : Determination of water absorption

Part III : Determination of efflorescence
Percentage of Deleterious materials (testing).
STANDARD SPECIFICATION

FOR

PRECAST CONCRETE PIPES
(NP3 CLASS)
SPECIFICATION: PRECAST CONCRETE PIPES (NP3 CLASS)

1. SCOPE

The Scope of this Specification covers the requirements for reinforced precast cement concrete, medium duty, and non-pressure pipes known as NP3 class.

REFERENCE CODES

For pipe materials, the following codes shall apply:
- Specification for Precast Concrete Pipes (With and Without Reinforcement) IS: 458
- Code of Practice Laying Concrete Pipes IS: 783

2. MATERIALS

For precast concrete pipes, materials complying with the Requirements given below can be used.

CEMENT

Cement used for the manufacture of unreinforced and reinforced pipes shall confirm to is 269 or is 456 or is 1489 (part1 or part2) or is 8041 or is 8043 or is 8112 or is 12269 or is 12330.
AGGRIGATES

Aggregates used for the reinforced and unreinforced pipes shall confirm to IS 383. The maximum size of aggregate should not exceed one third thickness of the pipe or 20 mm whichever is smaller for pipes above 250 mm internal diameter. Max size of aggregates should be 10 mm for pipes having internal diameter 80 to 250 mm.

REINFORCEMENT

Reinforcement used for the reinforced pipes shall confirm to mild steel grade 1 or medium tensile steel bars confirming to IS 432 (part 1) or hard drawn steel wire confirming to IS 432 (part 2) or structural steel bars confirming to IS 2062. The minimum clear cover for the reinforcement shall be as given below:

<table>
<thead>
<tr>
<th>SL NO</th>
<th>DESCRIPTION</th>
<th>MIN. CLEAR COVER (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Barrel wall thickness up to an including 75 mm</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>Barrel wall thickness over 75 mm</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>At spigot steps</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>At end of longitudinal</td>
<td>5</td>
</tr>
</tbody>
</table>
CONCRETE

The concrete quality shall be as per IS 456 for at least very severe environment exposure condition in the case of pipes manufactured by vibrated casting process (the type we are using here). The concrete shall have a minimum compressive strength of 35 n/sq mm at 28 days. Compressive tests shall be conducted on 150 mm cubes in accordance with the relevant requirements of IS 456 and IS 516. The manufacturer shall give a certificate indicating the quantity of cement in the concrete mix.

RUBBER RING

Rubber ring chords used in pipe joints shall confirm to type 2 of IS 5382.

WATER

Water used for mixing of concrete and curing of pipes shall confirm to 5.4 of IS 456.

CHEMICAL ADMIXTURES

In case of the use of admixtures for manufacturing, shall confirm to IS 9103.
All Pipes must be new and perfectly sound, free from cracks, cylindrically straight, and of standard nominal diameter and length with even texture. Each pipe shall have one collar with it.

Spun Yarn for pipe joints shall be best quality. It shall be free from dust etc.

3. DIMENSIONS

The internal diameter, barrel wall thickness, length, the minimum reinforcement and strength test requirement for np3 classes of pipes manufactured by vibrated casting process are given below.

<table>
<thead>
<tr>
<th>INTERNAL DIAMETER (mm)</th>
<th>MINIMUM BARREL THICKNESS (mm)</th>
<th>REINFORCEMENT</th>
<th>STRENGTH REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LONGITUDINAL</td>
<td>LOAD TO PRODUCE 0.25 MM CRACK</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPIRAL</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>115</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. TOLERANCES

The following tolerances are permitted.

In the case of overall length-plus or minus 1 percent of the standard length tolerance is permitted.

For internal diameter of pipes ,having diameter over 300 mm up to and including 600 mm can have a max tolerance of  plus or minus 5mm. and for pipes having a diameter over 600 mm can have max tolerance of plus or minus 10mm.
In the case barrel wall thickness, for the pipes having a barrel wall thickness over 65 mm up to and including 80 mm, a max tolerance of plus 5 and minus 2.5 can be permitted and for pipes having a battle wall thickness over 80mm up to and including 95 mm, a max tolerance of plus 7 and minus 3.5 can be permitted.

5. TRANSPORTATION AND STACKING

The transportation of materials to the worksite and stacking shall be done in a manner to cause minimum inconvenience to the traffic and other construction work.

Pipes should be loaded at the works for transportation by either by rail or road, in such a way that they are secure and no movement can take place on the vehicle during transit. The Pipe shall be protected during handling against impact, shocks and free fall to avoid cracks and damage.

6.1 OFFLOADING

Offloading may be carried out by means of chain block with shear legs or crane adequate capacity using properly designed slings and spreader beams or specially designed lifting beams.

6.2 STAKING
Pipes may be placed directly on the ground provided if it is reasonably level and free from rocks and other projections. Stacking in tiers are permissible if timber bearer are placed between succeeding tiers.

6.3 STRINGING
Stringing consists of lowering of pipes on the ground in line ready for laying. Care is again needed to prevent damage during this operation.

The Contractor shall be fully responsible for the safety and security of materials transported and stacked in the field.

7. LOWERING AND LAYING OF PIPES

7.1 General
The laying and jointing of pipes shall confirm to IS: 783. Pipes shall be joined by collar Joints.

The trench shall be checked for proper level, grade and alignment before lowering the pipes. Trench shall be of sufficient width to provide a free working space shall be preferably not less than 150 mm on the both sides.

7.2 LOWERING
The pipe shall be lowered cautiously to prevent disturbance of the bed and sides of the trench. The heavy Pipes shall be lowered by means of proper tripods, chain pulley blocks or as directed by
Engineer-in-charge. Great care should be taken to prevent sand, etc., from entering the Pipes.

7.3 LAYING

Laying of Pipes shall proceed upgrade of slopes.

The error of grade shall not be rectified by packing up earth underneath the pipe. If required, concrete shall be used for packing.

The ends of the Pipes shall be kept closed to keep dirt, mud and foreign materials out. Adequate provision shall be made to prevent floating of pipes in the event of flooding of trenches.

The body of pipe for its entire length shall rest on an even bed in the trench and places shall be excavated to receive the collar for the purpose of jointing.

When laying is not in progress, open end of the pipe line should be fitted with temporary end closure.

7.4 JOINTING.

The sections of the pipes should be jointed together in such a manner that there shall be as little unevenness as possible along the inside of the pipe. The procedure will vary according to the type of joints being used. For collar joints the procedure is given below,

A few skeins of spun yarn, soaked in neat cement wash shall be inserted in the groove at the end of the pipe and the two adjoining pipes butted against each other. The collar shall than be slipped
over the joint covering equally both the pipes. Spun yarn soaked in neat cement wash shall be passed round the pipes and inserted in the joint by means of caulking tools from both ends of the color. More skeins of yarn shall be added and well rammed home. The object of the yarn is to center the tow ends of the pipes within the collar and to prevent the cement mortar of the joint penetrating into the pipes.

Cement Mortar 1:2 (1 cement: 2 Sand) shall be slightly moistened and must on no account be soft or sloppy and shall be carefully inserted by hand into the joint. The mortar shall than be punched and caulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall be finished off neatly outside the collar on both sides at an angle 45°.

Any surplus mortar projecting inside the joint is to be removed and the guard against any damage sack or gunny bags shall be drawn past each joint after completion.

Curing
The Cement mortar joints shall be cured at least for seven days.

7.5 CHANGE OF DIRECTION

Small changes in direction may be made by setting adjectives pipes at slight angle to each other. max angle will vary with the type of joint used and is a meter of pipe.

6. TESTING
Test specimens
All pipes for testing shall be selected at random from the stock of the manufacturer. During manufacture test on compressive strength has to be done as described in IS 516. All specimens selected shall be subjected to the following tests in accordance with IS 3597.

a) Hydrostatic test
b) Three edge bearing test
c) Permeability test.
The permeability test when conducted in accordance with the method described in IS 3597 shall meet the requirement of final permeability which shall not exceed 0.3 cu.cm.

All of the pipes selected shall be inspected for dimensional requirements, finish, and deviation from straight as given in IS 458. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

7. PAYMENT
Payment shall be made on Running Meter basis, which includes supplying, lowering, laying, jointing, curing, all complete.
GENERAL SCOPE

FOR

CIVIL MATERIALS
GENERAL SCOPE FOR CIVIL WORKS:

1.1 This specification establishes and defines the general requirements of various materials to be used in General Civil Works.

1.2 Whenever any reference to BIS Codes is made, the same shall be taken as the latest revision (with all amendments issued thereto) as on the date of submission of the bid.

1.3 Apart from the BIS Codes mentioned in particular in the various clauses of the materials specifications, all other relevant codes related to specific job under consideration regarding quality, tests testing and/or inspection procedures shall be applicable. Reference to some of the Codes in the various clauses of this specification does not limit or restrict the scope of applicability of other referred or relevant codes.

1.4 In case of any variation/contradiction between the provision of BIS Codes and the particular material specification, the provision given in the material specification shall be followed.
1.5 All the materials shall be of standard quality and shall be procured from renowned sources/manufacturers approved by the Engineer-in-charge. It shall be the responsibility of the Contractor, to get all materials/manufacturers approved by the Engineer-in-charge prior to procurement and placement of order.

1.6 Whenever called for by the Engineer-in-charge, all tests of the materials as specified by the relevant BIS Codes shall be carried out by the Contractor in an approved laboratory and test reports duly authenticated by the laboratory, shall be submitted to the Engineer-in-charge for his approval. If so desired by the Engineer-in-charge, tests shall be conducted in the presence of the Engineer-in-charge or his authorized nominee.

1.7 Quality and acceptability of materials not covered under various materials specifications shall be governed by the relevant BIS codes. In case BIS code is not available for the particular material, other codes e.g. BS or DIN or API/ASTM shall be considered. The decision of Engineer-in-charge, in this regard, shall be final and binding on the Contractor.
1.8 Whenever asked for, the Contractor shall submit representative samples of materials to the Engineer-in-charge for his inspection and approval. Approval of any sample does not necessarily exempt the Contractor from submitting necessary test reports for the approved material, as per the specification/relevant BIS codes.

1.9 The Contractor shall submit manufacturers test reports on quality and suitability of any material procured from them and their recommendation on storage, application, workmanship etc., for the intended use. Submission of manufacturer’s test reports does not restrict the Engineer-in-charge from asking fresh results from an approved laboratory of the actual material supplied from an approved manufacturer/source at any stage of execution of work.

1.10 All costs relating to or arising out of carrying out the tests and submission of test reports and or samples to the Engineer-in-charge for his approval during the entire tenure of the work shall be borne by the Contractor and included in the quoted rates.

1.11 Materials for approval shall be separately stored and marked as directed by the Engineer-in-charge and shall not be used in the works till these are approved.
1.12 The Contractor at his own cost shall immediately remove all the rejected materials from the site.

1.13 For all the minor minerals extracted by the Contractor like aggregates, rubble, sand etc., Contractor is liable to take proper approval from appropriate/competent authority as per Bombay Minor Minerals Extraction Rules 1955 before lifting the materials.

1.14 All the royalty payments etc. as deemed admissible to statutory / govt. authorities will be paid by contractor for all the murrum brought for HPCL works.

1.15 It shall be the responsibility for the contractor to produce all such royalty payments, approval documents to Engineer-in-Charge during submission of running bill. At the end of work no objection certificate from relevant authorities will be submitted to ensure that HPCL is kept free from all encumbrances.
STANDARD SPECIFICATIONS

FOR

TESTING OF

CONSTRUCTION MATERIALS
TESTING OF CONSTRUCTION MATERIALS

THE CONTRACTOR SHALL CARRY OUT THE FOLLOWING TESTS AS MINIMUM AT HIS OWN EXPENSE AND AS DIRECTED BY THE ENGINEER-IN-CHARGE. ALSO ENGINEER-IN-CHARGE RESERVES THE RIGHT TO DIRECT THE CONTRACTOR TO CARRY OUT ANY FURTHER TESTS ON ANY MATERIAL WHICH IS BEING USED IN THE PROJECT AT CONTRACTOR’S COST.

1. WATER: SUITABILITY FOR CONSTRUCTION/ CONCRETING PURPOSES AS PER IS 456-2000

PERIODICITY: ONE TEST AT THE BEGINNING OF THE PROJECT AND ONCE IN EVERY 3 MONTHS AS PER IS CODE

2. SAND
TESTS TO BE CONDUCTED
A. PARTICLE SIZE - LAB
B. SILT CONTENT - FIELD
C. BULKING OF SAND-FIELD
D. PERCENTAGE OF DELETERIOUS MATERIAL / ORGANIC IMPURITIES - LAB

IS CODE FOR MATERIAL - IS-383-1970
IS CODE FOR TESTING - IS-2386 (PART I) TO IS-2386 (PART VIII)
PERIODICITY OF TESTING
WHENEVER THERE IS A CHANGE IN SOURCE OF SUPPLY OR AS DIRECTED BY THE ENGINEER-IN-CHARGE.

REMARKS
1. SILT CONTENT SHOULD NOT EXCEED 8%.
2. FOR SAND PAD FOUNDATION NO NEED OF PARTICLE SIZE DISTRIBUTION. ONLY SILT & BULK CONTENT TO BE CARRIED OUT.

SAND (FOR PLASTERING)
TESTS TO BE CONDUCTED
A) PARTICLE SIZE - LAB
B) SILT CONTENT - FIELD
C) PERCENTAGE OF DELETERIOUS /ORGANIC IMPURITIES - LAB.

IS CODE FOR MATERIAL - IS-1542
IS CODE FOR TESTING - IS-1727

PERIODICITY OF TESTING
SAME AS ABOVE, TEST SHALL BE REPEATED FOR MINIMUM QTY. 500 SQ. M OF PLASTERING.

REMARKS
1. SILT CONTENT NOT TO EXCEED 8%
2. SAND TO BE SIEVED IN SIEVE SIZE 4.75 MM

3. COARSE AGGREGATE
TESTS TO BE CONDUCTED
A. PERCENTAGE OF SOFT DELETERIOUS MATERIALS - FIELD (VISUAL)

B. PARTICLE SIZE DISTRIBUTION

C. AGGREGATE VALUE:
   1. CRUSHING - LAB
   2. IMPACT - LAB
   3. ABRASION - LAB (ONLY FOR ROADS)

IS CODE FOR MATERIAL - IS-383-1970
IS CODE FOR TESTING - IS-2386 (PART I) TO IS 2386 (PART VIII)

PERIODICITY OF TESTING

MINIMUM 45 CUM. TESTS TO BE REPEATED FOR EVERY 45 CUM OF COARSE AGGREGATE OR PART THEREOF.

REMARKS

PERCENTAGE OF SOFT DELETERIOUS MATERIALS. USUALLY VISUAL INSPECTION SHALL BE CARRIED OUT. IF ENGG.-IN-CHARGE / ARCHITECTS HAS DOUBTS, THE SAME MAY BE TESTED IN LAB.

4. CEMENT

TESTS TO BE CONDUCTED

A. FINENESS - LAB

B. SOUNDNESS - LAB

C. SETTING TIME - LAB

D. COMPRESSIVE STRENGTH - LAB

PERIODICITY OF TESTING
MINIMUM QTY. 20 MT, TESTS TO BE REPEATED FOR EVERY 50 MT OR PART THEREOF OR CHANGE OF SUPPLIER.

REMARKS
CEMENT TO BE TESTED IF SUPPLIED BY THE CONTRACTOR.
CEMENT TO BE TESTED IF STORED FOR MORE THAN 3 MONTHS.

5. CEMENT CONCRETE
TESTS TO BE CONDUCTED
A. SLUMP TEST - FIELD
B. CUBE STRENGTH - LAB/FIELD
C. BEAM TEST (TRANSVERSE STRENGTH TEST)

PERIODICITY OF TESTING
A. ONCE FOR MINIMUM 5 CUM.
B. REPEATED FOR EVERY 15 CUM OR PART THEREOF.
REMARKS:
CUBE STRENGTH TO BE TAKEN FOR BOTH 7 DAYS (THREE CUBES) AS WELL AS 28 DAYS (THREE CUBES). CUBES OF CRITICAL MEMBERS (DECIDED BY ENGG.-IN-CHARGE) SHALL BE TESTED AT LAB.

6. REINFORCEMENT STEEL
TESTS TO BE CONDUCTED
A. FREE FROM DEFECTS - FIELD (VISUAL)
B. WEIGHT - LAB
C. SIZE - LAB
D. ULTIMATE TENSILE STRESS - LAB  
E. YIELD STRESS - LAB  
F. ELONGATION PERCENTAGE - LAB  
G. BEND RE-BEND TEST - LAB  

IS CODE FOR MATERIAL  
- IS-432 FOR MILD STEEL  
- IS-1786 FOR TOR STEEL  

IS CODE FOR TESTING - IS-1608  

**PERIODICITY OF TESTING**  
MINIMUM QTY. 10 MT, TESTS SHALL BE REPEATED FOR EVERY 10 MT OF EACH SIZE (DIA) OR PART THEREOF.  

**REMARKS**  
A. STEEL SHALL BE TESTED IF SUPPLIED BY CONTRACTOR.  
B. STEEL SHALL BE TESTED IF STORED IN OPEN YARD FOR MORE THAN ONE YEAR.  

**NOTE:** ALL THE TESTING EQUIPMENTS/ MACHINES LIKE SIEVE, COMPRESSION TESTING MACHINE ETC. REQUIRED FOR FIELD TESTS SHALL BE ARRANGED BY THE PARTY AT SITE. IN CASE OF FAILURE OF MACHINE, TESTING TO BE CARRIED OUT BY THE CONTRACTOR AT LAB AT NO EXTRA COST  

**7. BRICKS**  
**TESTS TO BE CONDUCTED**  
A. COMPRESSIVE TEST - LAB  
B. WATER ABSORPTION - LAB
C. EFFLORESCENCE - LAB
D. PERCENTAGE OF DELETERIOUS MATERIAL - LAB.
E. DIMENSION TEST-LAB

IS CODE FOR MATERIAL - IS-1077-1986
IS CODE FOR TESTING - IS-3495 (PART I) TO IS-3495 (PART III)

PERIODICITY OF TESTING
MINIMUM 20000 BRICKS BUT TESTS SHALL BE REPEATED FOR EVERY 40000 OR PART THEREOF DEPENDING ON THE VOLUME OF WORK.

8.0 TILES
TESTS TO BE CONDUCTED
TOLERANCE IN SIZE (+/- 1 MM ON LENGTH & BREADTH)
THICKNESS OF WEARING LAYER – LAB
WATER ABSORPTION – LAB
TRANSVERSE STRENGTH – LAB
ABRASION STRENGTH - LAB
IS CODE FOR TESTING AS PER STANDARD

PERIODICITY OF TESTING
2 SAMPLE TILES TO BE TESTED FOR MINIMUM QUANTITY OF 80 SQM

6. STRUCTURAL STEEL
TESTS TO BE CONDUCTED
A. FREE FROM DEFECTS - FIELD (VISUAL)
B. WEIGHT - LAB
C. SIZE - LAB  
D. ULTIMATE TENSILE STRESS - LAB  
E. YIELD STRESS - LAB  
F. ELONGATION PERCENTAGE - LAB  
G. BEND RE-BEND TEST - LAB  

IS CODE FOR MATERIAL:  
· IS-2062 FOR STRUCTURAL STEEL  

PERIODICITY OF TESTING  
ATLEAST ONCE FOR ENTIRE WORK, TO BE REPEATED IF QUANTITY EXCEEDS 10 MT. TESTS SHALL BE REPEATED FOR EVERY 10 MT OF EACH SIZE (DIA) OR PART THEREOF.  

REMARKS:  
A. STEEL SHALL BE TESTED IF SUPPLIED BY CONTRACTOR.  
B. STEEL SHALL BE TESTED IF STORED IN OPEN YARD FOR MORE THAN ONE YEAR.  

NOTE:  
The material testing can be carried out at any of the govt. authorized material testing laboratories like,  

C.S.R.L  
"PROGRESS HOUSE",  
54, Mumbai-Pune Road,  
Shivajinagar,  
Pune-411005,  
Tel no 91-20-25541721/27
STANDARD SPECIFICATIONS
FOR
BUILDING WORKS
A. MATERIALS

WATER:

Water to be used shall conform to IS-456 Latest Edition. Water used shall be clean. Generally potable water is considered satisfactory for construction and curing purpose.

CEMENT:

Cement used shall be any one of the following
1. Sulphate Resistant Cement conforming to IS 12330- Latest edition
2. Portland Pozzolana Cement conforming to IS 1489 - Latest edition
3. Portland Slag Cement conforming to IS 455 - Latest edition
4. Ordinary Portland Cement conforming to IS: 269 or IS: 12269 shall be used.

AGGREGATES:

Coarse aggregates for cement concrete works shall be locally available hand broken/ crushed stone aggregates conforming to IS: 383-1970.
Fine aggregates shall be naturally occurring river sand with other properties conforming to IS: 383-1970.
BRICKS

Common burnt clay having minimum compressive strength of 35 kg/ Sq. cm conforming to IS 1077-1976 shall be used. Bricks shall be hand or machine moulded and free from cracks and flaws and nodules of free lime. Bricks shall be provided with frog 1 to 2 cm deep on one of its flat side.

SAND

Sand used for plastering purposes shall be hard, durable clean, free from adherent organic matters and shall conform to IS 1542-1977. Coarse sand shall be sieved at site if sand of 1542 quality is not available at site. Sand used for concrete shall conform to Grading Zone 1.11 or 111 of IS 383-1970 But in no case to zone IV.

PAINTS:

(For external surfaces) Berger (Weather Coat smooth) or equivalent approved make. Enamel Paint & Zinc Phosphate Primer: Asian/ Berger/ Jenson & Nicholson/ Shalimar

B. MATERIAL SPECIFICATIONS

EARTHWORK:

SETTING OUT AND MAKING PROFILE:
Masonry pillars will be erected at suitable points. These bench marks shall be connected to standard bench mark. Setting out of work shall be carried out with total station only. In addition to these pillar center line pillars shall also be erected by the Contractor and footing positions shall be marked with the help of these pillars. The necessary profile shall be set out. The level shall be taken at an interval as directed by EIC.

The levels shall be recorded in field books and plotted on plan before starting the excavation.

EXCAVATION FOR FOUNDATION:
The cutting shall be done to minimum depths as per drawings and as advised by EIC. Any excess excavation carried out by the Contractor without proper permission from EIC shall not be paid and the excess depth shall be made good by the Contractor by PCC 1:4:8 at contractor’s own cost.

In case water is encountered during the excavation for foundation, or flooding of pits due to any other reasons the contractor shall arrange for dewatering the same at his own cost.

SPECIFICATIONS FOR MURRUM FILLING

QUALITY OF MURRUM:
The murrum shall be naturally occurring material formed by disintegration of rock. It shall be free from vegetarian, rubbish or material of organic origin and scales deleterious to concrete and reinforced concrete.
Pieces of hard rock which do not get crushed under the roller shall not exceed 50mm size.

FILLING:

Filling shall be done in 20cm thick layers and every layer shall be power rolled with 10 ton roller so as to achieve maximum compaction and till such time that no further movement is observed under the wheels of the roller.

After filling is completed the modified proctor density shall be 95% with OMC.

Before start of work the contractor shall supply the samples of murrum from each quarry to cover the variations expected in the supply. The samples shall be tested for the following in a recognized laboratory in accordance with IS:2720 for the following.

Silt and clay content.
Moisture-content and dry density relationship at modified Procter density.

Moisture Control: Water shall be always sprayed and not poured. Ponding shall never be allowed. In wet weather the work may have to be suspended. Care shall be taken to see that moisture is uniformly spread throughout the layer and where necessary mixing with harrows and rakes shall be done.

Measurements: Measurements shall be of the cubic contents of the completed filing and shall be determined by taking level of
testing ground and after final layer for each type of filing. All dimensions are for compacted thickness.

**BRICK MASONRY**

**SOAKING OF BRICKS:**

Bricks required for masonry shall be thoroughly soaked in clean water for at least one hour.

**LAYING:**

Bricks shall be laid in English bond unless otherwise specified. Half or cut bricks shall not be used except where necessary to complete the bond. Closure in such cases shall be cut to the required size and used near the end of the wall.

The walls shall be taken up truly plumb. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in alternate course shall come directly one over the other. The thickness of the brick courses shall be kept uniform.

All hold fasts of doors, windows, etc., which are required to be built in walls shall be embedded in cement mortar or in cement concrete as specified in their correct position as the work proceeds.
JOINTS:

Bricks shall be so laid that all joints are full of mortar. The thickness of joints shall not exceed one centimeter for brickwork of any class designation. All face joints shall be raked to a minimum depth of 10mm by a raking tool during the progress of work where the mortar is still green so as to provide proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done the joints shall be struck flush and finished at the time of laying.

The face of brickwork shall be cleaned on the same day on which brickwork is laid.

CURING:

Brickwork shall be protected from rain by suitable covering when mortar is green. Masonry work shall be kept constantly moist on all faces for a minimum period of seven days by spraying water.

ANTI TERMITE TREATMENT:-

SCOPE

The scope of job is to form a chemically treated soil barrier to prevent growth of nests or colonies of the sub terranian termites.

MATERIALS:

The following chemical (as specified) in water emulsion shall be used:
Chemicals | Concentration (by weight)  
--- | ---  
Chloropyrifos | 1.0%  

**PRE-CONSTRUCTION CHEMICAL TREATMENT:**

Hand operated pressure pumps shall be used for uniform spraying and proper check shall be maintained to ensure that specified quantity of chemical is used for the required area.

**TIME OF APPLICATION**

Anti-termite treatment shall start in foundation trenches and pits before laying the levelling course of PCC. The PCC shall be done only after the chemical emulsion has been observed by the soil and surface is quite dry. Treatment should not be carried out when it is raining or the soil is wet. The treated soil barriers shall not be disturbed after they are formed and if by chance, they are disturbed, the same shall be made good before laying the PCC.
PROCEDURE:

Treatment of Column Pits, Wall Trenches and Basement Excavation:-

The bottom surface and sides (up to 300mm) shall be treated with chemical at the rate of 5 litres/sq.m.

The portion of the column foundations and the retaining walls coming in contact with the backfill, the structure shall be treated at the rate of 15 litres/sq.m of the vertical surface. If water is used for ramming the earth fill then treatment shall be carried out after the ramming operation is completed by rodding the earth at 150mm c/c close to the structure surface and spraying the required quantity of chemical. For RCC framed structures using 1:2:4 or richer concrete the treatment shall start from a depth of 500 mm below ground level and there is no need to start the treatment from the bottom of excavation for columns and plinth beams. The earth from 500mm below the ground level and above shall be treated as described in previous paragraph. However, for RCC frame structure, there shall be no chemical treatment for column foundations.
Treatment of top Surface of Plinth Filling :-
The top surface of filled earth within plinth walls shall be treated with chemical emulsion at the rate of 5 litres/sq. M before the subgrade of floor is laid. Holes upto 50-70mm deep at 150mm centres shall be made to facilitate saturation of the soil with chemical emulsion.

Treatment of Junction of Wall and Floor :-
To achieve continuity of vertical chemical barrier on inner wall surfaces, small channels of 30 x 30mm shall be made at all the junctions before laying the subgrade and rod holes shall be made upto ground level at 150mm centres and chemical emulsion shall be poured at 15 litres/sq. M of the vertical surface.

Treatment of soil along external perimeter of Buildings :-
After the building is complete, rod holes shall be made along external perimeter at 150 mm centres and 300mm deep and these holes shall be filled with chemical emulsion at 5 litres/running metre of perimeter.

**RECORD OF CHEMICAL USED :**
A detail record of quantity of chemical used for each operation shall be kept at site duly approved by Engg.-in-Charge/Architects.
GUARANTEE
The contractor shall give a guarantee of 10 years for effective anti-termite treatment barrier.

MEASUREMENT:
The measurement shall be made in square metres on the basis of the plinth area of the building at plinth level only for all operations described above. Nothing extra shall be measured.

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

APPLICABLE CODES AND SPECIFICATIONS;
The following specifications, standards and codes are made a part of these specifications. All standards, tentative specifications, specifications, codes of practice referred to herein
shall be the latest editions including all applicable official amendments and revisions.

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

**APPLICABLE IS SPECIFICATIONS AND CODES OF PRACTICE:**

IS 269:- Specification for ordinary, rapid hardening and low heat portland cement.

IS 8112:- Specification for high strength ordinary, portland cement.

IS 1489 - Specification for portland - pozzolona cement.

IS 383:- Specification for coarse and find aggregates from natural source for concrete.

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

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

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

IS 3025:- Methods of sampling and test (Physical and chemical) water used in industry.
IS 432:- Specification for mild steel and medium tensile steel (parts I & II) bars and hard drawn steel wire for concrete reinforcement.

IS 1139:- Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement.

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

IS 1786:- Specification for cold twisted steel bars for concrete reinforcement.

IS 2645:- Specification for integral cement waterproofing compound.


IS 3370:- Code of practice for concrete structures for storage of liquids (Part I to IV)

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


IS 3596:- Safety code for scaffolds and ladders. (Part I & II)

IS 1200:- Method of measurement of building works.
In the event that state, city or other Government bodies have requirements, more stringent than those set forth in this specification, such requirements shall be considered part of this specification and shall supersede this specification where applicable.

The quality of materials, method and control of manufacture and transportation of all concrete works irrespective of the mix, whether reinforced or otherwise, shall conform to the applicable portion of this specification.

Engineer shall have the right to inspect the source/s of material/s, the layout of operations of procurement and storage of materials, the concrete batching and mixing equipment and quality control system. Such an inspection shall be arranged and approval of Engineer-In-Charge shall be obtained prior to starting of concrete work.

Concrete shall be mixed by mechanical mixer only and no hand mixing shall be allowed for RCC works.

GENERAL:

The quality of materials and method and control of manufacture and transportation of all concrete work irrespective of mix, whether reinforced or otherwise, shall conform to the applicable portions of this specification.

Engineer shall have the right to inspect the source/s of material/s, the layout and operation of procurement and storage of materials, the concrete batching and mixing equipment, and
the quality control system. Such an inspection shall be arranged and Engineer’s approval obtained, prior to starting of concrete work.

MATERIALS FOR STANDARD CONCRETE:

The ingredients to be used in the manufacture of standard concrete shall consist solely of a standard type portland cement, clean sand, natural coarse aggregate, clean water and admixtures, if specially called for on drawings or specifications.

CEMENT

The use of bulk cement will be permitted only with the approval of Engineer. Changing of brands or type of cement within the same structure will not be permitted.

CONTRACTOR will have to make his own arrangements for the storage of adequate quantity of cement. Cement bags shall be stored in a dry enclosed shed (storage under tarpaulin will not be permitted), well away from the outer walls and insulated from the floor to avoid contact with moisture from ground and so arranged as to provide ready access. Damaged or reclaimed or partly set cement will not be permitted to be used and shall be removed from the site. Not more than 12 bags shall be stacked in any tier. The storage arrangement shall be approved by engineer. Consignment of cement shall be stored as received and shall be consumed in the order of their receipt at site.

Cement held in storage for a period of Ninety (90) days or longer shall be tested. Should at any time Engineer have
reasons to consider that any cement is defective, then irrespective of its origin, date of manufacture and/or manufacturer’s test certificate, such cement shall be tested immediately at Contractor’s cost. Contractor shall not be entitled to any claim of any nature on this account.

CONSISTENCY:
The consistency of the concrete shall be such that it flows sluggish into the forms and around the reinforcement without any segregation coarse aggregate from mortar. The slump tests are mandatory and shall be carried out at regular intervals so that the consistency concrete can be monitored.

PLACING OF CONCRETE:
Concreting shall commence only after inspection and written approval by EIC.
Shuttering shall be clean and free from deposits of foreign materials and proper de-shuttering agent shall be applied to the surface.
Proper arrangements shall be provided for conveying the concrete the place of deposition without disturbing the reinforcement.

COMPACTION:
Concrete shall be compacted immediately after placing by means of mechanical vibrators.
All RCC works shall be cured for a minimum period of 14 days or more as advised by EIC.
INSPECTION AND RECTIFICATION OF DEFECTS:

Immediately on removal of forms, the RCC works shall be examined by the Engineer-in-Charge / Architects before any defects are made good.

The work that has sagged or contains honey combing to an extent detrimental to the structural safety or architectural concept shall be rejected.

Surface defects on a minor nature may be accepted and the same shall be rectified as follows:

a) Bulges due to movement of forms, ridges at forms, ridges at form joints shall be carefully chipped and then rubbed with a grinding stone.

b) Honeycombed and other defective areas must be chipped out, the edges being out as straight as possible and perpendicular to the surface. Shallow patches are first treated with a coat of thin grout (1 cement : 1 sand) and then filled with mortar similar to that used in concrete. Large and deep patches shall be filled up with concrete held in place by forms and shall be reinforced.
c) Holes left by bolts shall be filled carefully with mortar. Holes extending right through the concrete shall be filled with mortar with a pressure gun.

d) The same amount of care to cure the material in patches should be taken as with the whole structure.

POST TREATMENT OF SURFACE:
The surface which has to receive plaster or where it has to be joined with brick masonry walls shall be properly roughened immediately after the shuttering is removed.

ACCEPTANCE CRITERIA OF CONCRETE WORK:
Minimum of six sample cubes shall be taken for all concreting work (periodicity as specified in 9.6 of section III) and three cubes shall be tested after 7 days curing and balance after 28 days curing.

7 Days Test:
The average strength of the three specimens shall be accepted as the compressive strength of the concrete provided that the difference between maximum and minimum strength of the three cubes does not exceed 15% of average strength.
In case the 7 days strength is not satisfactory all further work structurally interlinked with the concrete represented by the samples shall be stopped till the remaining three cubes are tested for 28 days strength and are found satisfactory.

**28 Days Test:**

The tests should generally be carried out on 28th day, but in no case, should be delayed beyond 35 days. The strength of the cubes shall be as specified in IS: 456-2000 if they are tested on the 28th day. In case, the cubes are tested after 28 days, the minimum acceptable compressive strength shall be increased by 1.5 kg/cm² for each day beyond 28th day.

The acceptance criteria of 28 days test shall be as follows;

a) If the average compressive strength of three cubes is more or equal to the comp. Strength shown in table above, the concrete shall be accepted at full rates.

b) If the average comp. Strength of the three cubes is less than specified but not less than 75% of the specified strength, the concrete shall be accepted at reduced rates at the discretion of EIC. The reduced rate shall be calculated on proportionate
basis, i.e. for every percent decrease in the specified strength the rate shall be reduced by the same percentage.

c) If the average compressive strength of the three cubes is less than 75% of the specified strength, EIC shall either reject the defective portion or get it dismantled along with the structurally connected work as considered necessary at the risk and cost of the contractor. EIC may also desire to carry out additional tests on the defective work and if on the basis of these additional tests, EIC is satisfied about the structural adequacy of the concrete the concrete work may be accepted at the reduced rate as specified in b) above except, for the reduced strength below 75% for which the reduction shall be 1.5 times for every percent decrease below 75%

Example: Average compressive strength is 70% of specified strength. The rate payable shall be $75 - (1.5 \times (75-70)) = 67.5\%$ of tendered rate.

Further to the above, the work executed shall be in conformity to the diagrams geometrically within a tolerance of 25mm only. Contractor to strive for zero tolerance where ever possible.

**MEASUREMENT**

All measurements shall be as per IS:1200
PLASTERING

PREPARATION OF SURFACE:

The following surface preparation shall be made for both single and double coat plasters. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

In case of concrete where plaster is to be applied, the surface shall be first chipped by chiselling and wire brushing to make the surface rough to receive the plaster, then the surface shall be cleaned of any loose particles/dust.

CEMENT PLASTER (SINGLE COAT)

APPLICATION:

Plastering shall be started from the top and worked down towards the floor. All holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true surface, plaster of about 15 x 15cm shall be first applied horizontally and vertically, at 3 metres intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform manner slightly more than the specified thickness and brought to true surface by working a wooden straight edge reaching across the gauges with small upward and sideways movements at a time.
All corners, arises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, junctions, etc., where required shall be done without any extra payment. Such rounding or chamfering shall be carried out with proper templates to the sizes required.

Horizontal joints in plaster shall not occur on parapet tops and copings as these invariably lead to leakages. Good quality lime neroo shall be applied to plastered surface with steel trowel to a thickness slightly more than specified and rubbed down to give overall thickness of 12mm and polished to a perfectly smooth and even finish working from top to bottom.

Curing shall be commenced as soon as the plaster has hardened sufficiently. This shall be done by spraying water at regular intervals.

**CEMENT PLASTER (TWO COAT WORK):**

The plaster shall be applied in two coats as detailed below:

- Apply 12mm thick coat of CM 1:4 mixed with CICO / ACCO Proof water proofing compound mixed as per manufacturer’s specifications as 1st cost leaving the surface rough.

When the plaster has been brought to true surface with a wooden straight edge the surface shall be left rough with 2mm deep furrows shall be made with a scratching tool to form key for the
finishing coat. The surface shall be kept wet till the finishing coat is applied.

Apply 2nd coat of 8mm thick of CM 1:3 and finishing the surface by rubbing with sponge till uniform texture is obtained.

The finishing coat shall be applied after the undercoat has sufficiently set but not dried and in any case within 48 hours of laying the first coat.

**Water Proofing**

All water proofing works to be carried out in this scope of work shall be through the following approved agencies / any other reputed approved local agency: -

For Cement Based Water Proofing:

(i) Indian water Proofing Company.

(ii) Leak proof - Waterproofing Corporation of India.

(iii) Nina Industries.

(iv) Hindustan Waterproofing.

(v) Overseas Waterproofing.

Contractor will be required to submit a guarantee in respect of performance of waterproofing for 10 years on stamp-paper. In addition to this, an amount equal to 10% of cost of waterproofing items shall be retained as retention money for 2 years from the date of completion, which shall be returned only after successful completion of this period.
CEMENT PAINTING

All outside exposed surfaces of masonry and concrete shall be painted with cement paint of approved make and shade. The surface shall be thoroughly cleaned & wetted with water just before the painting commence. Cement paint shall be mixed with water as per the specification of manufacturer. Cement paint which can be used within an hour of its mixing shall be prepared.

STEEL REINFORCEMENT

For super structure item mentioned in the job schedule only cold twisted HYS bars conforming to IS: 1786-latest edition shall be used.

Providing and fixing in position, steel reinforcement bars of various diameters for RCC piles as per detailed designs, drawings and schedule including cutting, bending, hooking the bars, binding with wires, tack welding and placing the reinforcement cage in position with cover blocks as required etc., complete.

PLAIN CEMENT WORKS:

Mixing: It shall be done in mechanical mixers. Mixing by hand shall not be permitted unless specific prior permission of the EIC has been obtained in writing. In such a case, proportion of cement shall be increased as per IS:456.

CONSISTENCY:
The quantity of water to be used for each mix of 50 Kg cement to obtain the required consistency shall not be more than 34 litres for 1:3:6 mix. 30 Ltrs for 1:2:4 mix. In case of vibrated concrete, the limits specified shall be suitably reduced to avoid segregation. The quantity of water shall be regulated by carrying out regular slump tests.

LAYING:
The concrete shall be laid gently in layers not exceeding 150mm. Mechanical vibrators shall be used for compaction. Hand compaction may be carried out if permitted by IEC. Hand compaction shall be done with the help of tamping rods. Next layer of concrete shall be carried out before initial setting starts in the previous layer. When the concreting is suspended, necessary removal of laitance and roughening of surface for jointing shall be done before concrete sets. On the resumption of work the joint shall be thoroughly cleaned, roughened, watered and a grout of neat cement slurry (1 kg of cement in 2 Ltrs of water) shall be applied uniformly.

CURING: Green work shall be protected form rain by suitable covering. After about 1 to 2 hours of concreting, the surface of concrete shall be protected from drying. The following methods shall be adopted for curing. All foundation PCC strips shall be cured by spraying water and keeping the surrounding soil moist. The curing shall continue for minimum 14 days or more as advised by EIC. The masonry work can be started after 48
hours of concreting, but the curing shall continue for minimum 14 days along with masonry.

**MARBLE MOSAIC TILE FLOORING:**

**SCOPE:**

This covers the laying and finishing of cement concrete flooring tiles in floors, wall, staircases, etc.

**MATERIALS:**

Cement, sand, terrazo tiles shall conform to the specifications detailed in the Materials Section.

Mixing of mortar shall be done in accordance with the specification laid down under “Cement Mortars”.

**LAYING:**

Subgrade concrete or the RCC slab on which tiles are to be laid shall be cleaned, wetted and mopped. The bedding of the tiles shall be either with lime mortar 1:3 (1 lime putty : 3 sand) or cement mortar 1:3 or as specified. The average thickness of mortar shall be 30mm and thickness at any place shall not be less than 10mm.

Lime mortar bedding shall be spread, tamped and corrected to proper levels and allowed to harden for a day before the tiles are laid.
Over this bedding, neat grey cement slurry of honey like consistency shall be spread at the rate of 4.4 kg/sq.mt over such an area that would accommodate 20 tiles.

Before laying, the tiles shall be soaked in water for at least 20 minutes and then allowed to dry for about 10 minutes. It is necessary to have tiles damp but not wet when they are laid. Tiles shall be fixed by gently tapping with a wooden mallet till they are properly bedded and in level with the adjoining tile. The joints shall be kept as thin as possible not exceeding 1.5 mm. Where full-size tiles cannot be fixed, tiles shall be cut to the required size and their edges rubbed to ensure a straight and true joint. Tiles which are fixed in the floor adjoining the wall shall enter not less than 12mm under the plaster, skirting or dado. After the tiles have been laid, excess cement coming out through the joints upto the surface shall be immediately wiped clean.

**CURING, POLISHING AND FINISHING:**

The day after the tiles are laid all joints shall be cleaned of the grey cement with a wire brush. The joints shall after 24 hours be filled with matching cement paste and allowed to set. The same
Cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

The floor shall then be kept wet and protected for a minimum period of seven days before starting the polishing. No one shall be allowed to walk on the floor during the first 24 hours immediately after the tiles are laid.

The surface shall thereafter be grounded evenly with machine fitted coarse grade grit block. Water shall be used profusely during grinding. It shall then be covered with a thin coat of cement mixed with colouring pigment to match the topping of the wearing surface of the tile sand second grinding shall then be carried out with machine fitted with fine grade grit blocks.

The final grinding with machine fitted with the finest grade grit blocks shall be carried out after 24 hours of completion of second grinding or before handing over the floor. The entire surface shall be finally washed with weak solution of soft soap in warm water.
For small areas or where circumstances so require, hand polishing may be permitted as in the case of skirting, treads and risers of staircase, etc. by the Engg.-in-charge / Architects.

MEASUREMENT:
Length and breadth dimensions shall be measured to the correct centimetre before laying skirting, dado or wall plaster and area calculated in square metres correct to two decimal places. No deduction shall be made nor extra amount paid for any opening in the floor area upto 0.5 sq.m. No extra shall be paid for use of cut tiles nor for laying the tiles at different levels in the same room.

TILES IN SKIRTING
PREPARATION OF SURFACE:
The joints of masonry shall be raked out to a depth of at least 15mm. In case of concrete and plastered surfaces, the surface shall be roughened by hacking. All the surfaces receiving tiles shall be cleaned thoroughly, washed with water and kept wet before the tiling is commenced.
LAYING:

12mm thick plaster of CM 1:3 or mixed as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes making grooves of at least 2mm deep before the plaster dries. The tiles shall be soaked in water. The tiles shall be buttered with a coat of grey cement slurry and then shall tamped in position corrected to proper planes and lines with a wooden mallet. The tiles shall be set in required pattern and butt jointed with very fine joints. Top of skirting or dado shall be truly horizontal and joints truly vertical unless specified otherwise. The skirting or dado shall rest on the top of flooring. The projection of skirting from the finished wall surface shall not be more than 12mm.

POINTING AND FINISHING

Joints shall be cleaned off grey cement grout with wire brush or trowel to the depth of 2 to 3mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with colouring pigment if required to match the colour of the tiles. The wall shall be kept wet at least for seven days. The finished wall shall not sound hollow when tapped with a wooden mallet.
MEASUREMENTS:
Length shall be measured correct to a cm. Height shall be measured correct to a cm in case of dado and 5mm in case of riser and skirting. The area shall be calculated in square metres correct to two decimal places. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used.

PLASTIC EMULSION PAINT:
MATERIAL:
The plastic emulsion paint shall be of approved brand and manufacturer and of the required shade.

APPLICATION
The minimum two numbers of coats shall be applied. However in case additional coats are to be applied to get uniform finish, the same shall be done at no extra cost. The paint shall be applied with brushes or rollers. The thinning of the emulsion is to be done with water only and not turpentine. The quantity of
water to be added shall be as specified by the manufacturer. The surface finish shall be flat, velvety and smooth.

**PRECAUTIONS:**

Old brushes shall not be used. Splashes if any shall be cleaned immediately as they will be difficult to remove afterwards. Washing of the surface shall not be done within 3 to 4 week of application.

**MS DOORS**

<table>
<thead>
<tr>
<th>Part</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUTER FRAME</td>
<td>F X 8 (MIN WT 2.31 KG/M)</td>
</tr>
<tr>
<td>INNER FRAME</td>
<td>F X 6 (MIN WT 2.52 KG/M)</td>
</tr>
<tr>
<td>HORIZ GLAZING BAR</td>
<td>T2 (MIN WT 1.036 KG/M)</td>
</tr>
<tr>
<td>VERT GLAZING BAR</td>
<td>T3 (MIN WT 1.14 KG/M)</td>
</tr>
<tr>
<td>GLASS</td>
<td>5 MM THICK</td>
</tr>
<tr>
<td>KICKPLATE</td>
<td>14 SWG THICK UPTO 0.6 M HT</td>
</tr>
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</table>

**FIXTURES (HEAVY TYPE BRASS)**

<table>
<thead>
<tr>
<th>Part</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>HINGES</td>
<td>3 NOS ON EACH JAMB (PROJECTING TYPE)</td>
</tr>
<tr>
<td>TOWER BOLTS</td>
<td>250 MM LONG (1 NO PER SHUTTER)</td>
</tr>
<tr>
<td>DOOR STOPPER</td>
<td>1 NO PER SHUTTER</td>
</tr>
<tr>
<td>ALDROP</td>
<td>300 MM LONG (1 NO PER SHUTTER)</td>
</tr>
<tr>
<td>HOLDFAST</td>
<td>40 X 12 X 200 MM LONG FLATS</td>
</tr>
<tr>
<td></td>
<td>3 PER SHUTTER</td>
</tr>
</tbody>
</table>
MS WINDOWS

OUTER/INNER FRAME  F7D (1.419 KG/M)
CENTER MULLION  F4B (2.26 KG/M)
HRIZ GLAZING BARS  T6 (0.839 KG/M)
HORIZ COUPL MULLION  K12B (2.3 KG/M)
GRILL BARS  12MM SQUARE TYPE @ 100 WELDED TO FRAME
GLAZING  4MM GROUNDED GLASS
VERT.COUP.MULLION K11B (1.8 KG/M)
FIXTURES (HEAVY TYPE MS)

TOP/BOTTOM HINGES  2 NOS
MS TRAYS  2 NOS
LOCKING HANDLES  2 NOS

SPECIFICATIONS FOR ALUMINIUM SECTIONS

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>HPCL REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SECTION ----</td>
<td>JINDAL</td>
</tr>
</tbody>
</table>

HINDALCO

1.0 MAIN DOOR WITH HALF GLAZED AND HALF FIXED PANEL

<table>
<thead>
<tr>
<th>FRAME</th>
<th>4617(3.18 mm Thick)</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1169 VERTICAL STYLE</td>
<td>4526(3.0 mm Thick)</td>
<td></td>
</tr>
<tr>
<td>SP 1771 BOTTOM HORIZONTAL</td>
<td>4538(2.2 mm Thick)</td>
<td></td>
</tr>
<tr>
<td>SP 1772 TOP HORIZONTAL</td>
<td>4506(2.82 mm Thick)</td>
<td></td>
</tr>
<tr>
<td>1775</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MIDDLE HORIZONTAL 4506(2.82 mm Thick) SP 2205
HANDLE 1103 150 x6
AL
GLASS 5MM
5MM
TAPPER CLIPS SUITABLE
SUITABLE
ANTI VIBRATING/ SUITABLE
SUITABLE
ANTI RATTLING DEVICE
TOWER BOLTS 250 MM LONG AL
CONCEALED TYPE
LOCKING DEVICE STAINLESS STEEL
WITH THREE
KEYS
FINISH POWDER COATED

2.0 3 TRACK SLIDING WINDOWS

BOTTOM TRACK 8685
WS 1680
WATER DRAIN -
WS 1691
SIDE & TOP TRACK 8689
WS 1689
SHUTTER SIDE & TOP 8726
WS 1686
SHUTTER HANDLE 8665
WS 2440
SHUTTER INTERLOCK  8664
WS 2439
GLASS  5MM
5MM
ROLLER  SMOOTH OPERATION
WITH BALL BEARING
ANTI VIBRATING/ SUITABLE
SUITABLE
ANTI RATTLING DEVICE
LOCKING DEVICE  SUITABLE
SUITABLE
FINISH  POWDER COATED

3.0  2 TRACK SLIDING WINDOWS

BOTTOM TRACK  8732
WS 2434
WATER DRAIN -
WS 1691
SIDE & TOP TRACK  8759
WS 2433
SHUTTER SIDE & TOP  8720
WS 1471
SHUTTER HANDLE  8665
WS 1472
SHUTTER INTERLOCK  8664
WS 1473
GLASS  5MM
5MM
ROLLER SMOOTH OPERATION
WITH BALL BEARING
ANTI VIBRATING/ SUITABLE
ANTI RATTLING DEVICE SUITABLE
LOCKING DEVICE SUITABLE
FINISH POWDER COATED

ELECTRICAL INSTALLATION

Electrical installation shall be as per IS 732-1989 and IE rules.

Internal and external wiring in buildings shall be carried out in concealed PVC conduit of minimum 2 mm thickness. These PVC conduits shall be laid before canting concrete or by making chases in the brick wall and making good the wall after fixing of conduits at no extra cost.

Wiring for power and light/fan circuits shall be separate. Entire wiring shall be done by flexible PVC insulated copper conductors of specified (in the job schedule) size.

Point Wiring:

The following components are deemed to be included in point wiring.

1. Metal switch board
2. Control switches 5A/15A as specified.
3. PVC Channels with cover.
4. Copper conductors for neutral/live earthing.
5. Ceiling Roses
6. All accessories required for termination.

The above components shall meet the following specific requirements.

1) Switch Boxes
   Body : 16 SWG CRCA sheet. Flush type
   Size : Sufficient to accommodate required no. of switches.

2) Control Switches
   Fans : 5 Amps SP Switch
   Lights : 5 Amps SP Switch
   Power Plug : 15 Amps 3 Pin Plug combined SS type.

ERECITION AND EARTHING:

The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to the earthing conforming to the requirements by means of special approved type of earthing clamps efficiently fastened to conduit pipe in the workmanlike manner for a perfect continuity between earth wire and conduit. Gas or water pipe shall not be used as earth medium. If conduit pipes are liable to mechanical damage they
shall be adequately protected. In a conduit system the pipe must be continuous when passing through walls or floors.

An insulated copper earthing wire of green colour shall be provided having cross sectional area of 2.5 sq.mm. It shall be drawn in the conduit pipes along with the circuit wires for earthing of light fittings and pins of socket outlets.

JOIN AND LOOPING PACK:

Phase or live conductors shall be looped at the switch box and natural conductor can be looped either from the switch box or from the light fan or socket outlet.

In both systems of wiring, no bare or twist joints shall be made at intermediate points in the through run of cables, unless the length of final sub-circuit or sub-main is more than the length of the standard coil, as given by the manufacturer of the cable.

Wiring Termination:

All terminations must be mechanically and electrically sound. There should be maximum surface contact between the terminal and conductor and such contacts shall be tight since loose contact results in high resistance and over heating at the point. In case of securing a resistance conductor at a ordinary screw termination, it is preferable to loop the conductor in a clockwise direction as tightening the screw tends to close the loop rather than open it. At a pillar type terminal, the single conductor shall be bent back into itself and if two or more conductors are
to be terminated, they shall be twisted together before inserting into terminals.

Identification of Wires:

The phase conductors shall be of any of the RYB colours and the neutral conductor shall be of black colour. Further the phase conductors in one line shall be of only one colour i.e., either red blue or yellow. Earthing conductor shall be green.

Testing and commissioning:

After completion of installation, tests shall be carried out and test results shall be tabulated. Following are the tests to be carried out and test certificates shall be handed over to the Engineer-in-charge for records.

Lighting Distribution Boards:

a) Insulation test between phases, phases and neutral, phase and earth with 500 V meggar.

b) Operational Test

Safety Earthing:

a) All earthing circuits shall be checked for continuity. The earth resistance of all identifiable electrical equipment shall be measured and recorded.