standard to suit the application. In case Air Conditioning is required for VVVFD panel, same shall be provided by Vendor. Air Conditioning shall be suitable for specified area classification.

3.16.11 **Automatic Rescue Device (ARD)**

ARD shall be provided by Vendor for safe exit from car in case of power outage. This ARD shall consist of maintenance free DC Battery, battery charger & inverter which shall feed power to lift motor on power outage for inching operation in order to align the car with the nearest landing. On being aligned, the doors shall automatically open enabling safe exit of occupants from car. Make of ARD and DC batteries shall be subject to Purchaser's approval based on satisfactory past track record of the manufacturer. ARD shall be as per Vendor's standard to suit the application.

3.16.12 **Cabling**

All cabling from machine room PDB//Lighting Panel to all the loads shall be done with PVC insulated; FRLS, armoured cables whereas cabling between hoist way Junction box to the lift car shall be done with copper conductor, braided trailing cables. Separate and distinct trailing cable shall be provided for power, control, signalling, and lighting circuit. Minimum conductor size for power cable shall be 4 sq. mm and 2.5 sq. mm copper for control cable. Power cables up to 16 sq. mm conductor size shall be of copper conductor. All cables shall be FRLS type.

3.16.13 **Lighting**

Lighting within Lift Car, Hoistway & Pit is to be provided by Vendor and shall be LED type. Hoist way lighting shall be provided at regular interval in the hoist way for carrying out maintenance. Minimum one number lighting fixtures shall be provided by the Vendor at each landing in the hoist way.

3.16.14 **Earthing**

a) One no. earth plate shall be provided by Purchaser near PDB in machine room. Further distribution & connection of individual items with earthing system is under Vendor's scope.

b) The metal enclosure of all the electrical equipment shall have an effective earthing connection by means of two numbers earthing terminals.

3.16.15 Vendor shall supply suitable Cable glands and tinned copper lugs for equipments supplied by them. Cable details of purchaser's cable shall be provided during detail engineering.

3.16.16 Cable glands forming a part of relevant FLP enclosure shall be FLP type, testing by CIMFR or any other recognized independent testing laboratory and approved by CCOE/DGMS or any other statutory authority as applicable. Indigenous FLP glands shall have valid BIS license as per the requirements of statutory authorities.

3.16.17 All indicating lamps shall be LED type.

3.16.18 The lift package shall be complete with all the safety interlocks and devices for safe and reliable operation of the lift, all of which are included in Vendor's scope.

4.0 INSPECTION AND TESTING

Equipment shall be subjected to stage wise expediting, inspection and testing at Vendor's/Sub-vendor's works by purchaser/its authorised inspection agency. Vendor shall

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submit Inspection and Test Plan (ITP) before commencement of fabrication. Approved ITP shall form the basis for equipment inspection.

4.1 Testing at Works

4.1.1 Vendor shall perform tests and inspection necessary to ensure that the material and workmanship confirm to the requirement of this specification.

4.1.2 Testing at Vendor's works shall be carried out in accordance with applicable codes and shall include following tests as minimum.

a) Visual Check

b) Dimensional check

c) Assembly of major subassembly components such as drive unit, car body, doors.

d) Any or all the tests, at purchaser's option, shall be witnessed by purchaser/its authorized inspection agency. However, such inspection shall be regarded as check-up and in no way absolve the Vendor of his responsibility.

4.2 Performance Testing and Guarantees at Site

4.2.1 A field performance test shall be conducted by the Vendor to demonstrate the performance of the equipment after commissioning in accordance with Performance test procedure prepared as per EIL Standard 7-76-0103. The procedure of performance testing shall be submitted for Purchaser's review and shall be mutually agreed between the purchaser and the Vendor.

4.2.2 Vendor shall carry out the tests as required by the code and as per normal practice of the Lift industry. However following tests shall be carried out as a minimum:

a) Test to determine the motor, brake, control equipment, door locking devices and limit switches function correctly.

b) Brake shall be tested to check whether it can sustain a car at rest with 125 % of rated load.

c) Over speed test to determine that the safety gear stops the lift car with rated load. Over speed test shall be made with ropes attached all electrical apparatus operative except the over speed switch on the governor. The stopping distance of the lift car is the actual slide as observed from the marking on guides.

d) Test to determine the lift car raises and lowers rated load.

e) Test to determine that the lift car achieves the rated speed.

f) Accurate positioning of the lift at all landings.

g) Test to determine ARD's (Automatic Rescue Device) performance during power failure situation and check whether it reaches the nearest landing platform safely, without any problem.

Parameters mentioned at d), e) and f) above are part of performance guarantees.

4.2.3 During PGTR, performance parameters mentioned against cl. No. 4.2.2 (d, e, f) above shall be demonstrated by the vendor as per Owner's instruction for ten (10) times within One (1) hour duration with rated load for system acceptance by the owner.

4.2.4 In case vendor is not able to demonstrate/meet PGTR checkpoints as mentioned above three (3) times out of Ten (10) attempts, then vendor shall take corrective action and rectify the troubleshoot cause without any cost and time implication to owner till required performance is achieved.

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4.2.5 All parts of the lift shall operate satisfactorily with no vibration, noise, shock or display of any other unfavourable characteristics during the performance test.

4.2.6 Necessary instruments for the performance testing shall be arranged by the Vendor, and shall be tested and calibrated before undertaking the performance test. Only test load shall be provided by purchaser near test site.

4.2.7 If any additional loose instruments apart from installed ones are required to demonstrate performance guarantee test of the system, the same shall be arranged by the vendor which shall be duly tested and calibrated before undertaking the performance test. Vendor shall take back all such loose instruments after successful commissioning and system acceptance by purchaser.

5.0 ANNUAL MAINTENANCE CONTRACT (AMC)

After the warranty/guarantee period, comprehensive AMC services shall be available on chargeable basis from Lift vendor for regular maintenance (i.e. attending breakdown of lift within short notices, checking of clearances, necessary adjustment, lubrication etc.) including supply and replacement of damaged/failure/defective parts (Mechanical, Electrical, Instrumentation, software etc. with consumables) for which lift vendor shall quote AMC charges for 1st, 2nd and 3rd year after completion of warranty/guarantee period unless otherwise specified in the job specification. Vendor shall be obliged to provide AMC (renewable every year) for lifetime of the equipment. Comprehensive AMC charges shall be considered for price evaluation.

Notes:

A) Maintenance (Free as well as comprehensive AMC) shall consist of monthly examinations and any necessary adjustment and lubrication of the equipment by vendor's maintenance staff. The required supplies and spare parts shall be furnished by the vendor without any charges.

B) Attending breakdown of lifts shall be a part of maintenance work.

C) Any Operational failure shall be promptly attended to avoid any inconvenience to the residents of the residential complex. However, preventive maintenance shall be carried out by the vendor. Emergency and Man Trap rescue services shall be provided 24 hrs and 7 days by the vendor.

D) The software provided by the vendor for system operation shall be updated and upgraded on regular intervals with the latest patches or latest version as soon as it is available with them during the guarantee/warranty as well as comprehensive AMC period.

E) For software, vendor shall grant a non-exclusive license to the purchaser/end user to use the control software to operate the equipment for their own purpose.

Special Instructions for Foreign Vendor of Elevator: In case of foreign vendor, vendor is required to have Indian franchise having experience of providing similar services who shall undertake comprehensive AMCs as per Cl. No. 5.0 above and also attend elevator problems with-in warranty/guarantee/AMC period. Vendor shall furnish MOU with Indian franchise for the above arrangement along with offer.

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6.0 PROTECTION AND PAINTING

Surface preparation and painting shall be as per manufacturer's standard and shall be suitable for corrosive industrial environment unless otherwise specified in job specification/data sheet.

7.0 PACKAGING AND IDENTIFICATION

7.1 All packaging shall be done in such a manner as to reduce the volume. The equipment may be dismantled into major components, suitable for shipment and shall be properly packed to provide adequate protection during shipment. All assemblies shall be properly match marked for site erection.

7.2 Attachments, spare parts of the equipment and small items shall be packed separately in wooden-cases. Each item shall be appropriately tagged with identification of main equipment, item denomination and reference number of the respective assembly drawing.

7.3 Detailed packing list in water-proof envelope shall be inserted in the package together with equipment.

7.4 Each equipment shall have an identification plate giving salient equipment data, make, year of manufacture, equipment number, name of manufacturer etc.

7.5 Vendor shall furnish procedure for prolonged storage of supplied equipment/ material at site.

8.0 SPARE PARTS

8.1 Vendor shall submit list of two (2) years recommended spares with quantities and itemized price for the normal operation and maintenance of the lift along with the offer. Two (2) years recommended spares shall be ordered only in case Purchaser decides not to go for AMC services. Proper coding and referencing of spare parts shall be done so that later identification with appropriate equipment is facilitated.

8.2 Vendor shall supply adequate quantity of commissioning spares. The commissioning spares shall be sufficient for trouble free commissioning of the lift at site. Any commissioning spares required during commissioning, over and above the commissioning spares supplied, shall be made available by the vendor without any cost and time implication to purchaser. If for any reason, during commissioning, vendor needs to utilise spares from 2 years' operation spares (if already available at site), the same shall be replenished by vendor within a reasonable time without any cost implication to purchaser. Any unused commissioning spares shall be handed over to purchaser.

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STANDARD SPECIFICATION FOR CLASSIFICATION OF SOIL FOR EARTHWORK IN SITE GRADING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	14 03.19	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	AVM	AJS	RS	RKT
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Abbreviations:

gm/cc : Gram Per Cubic Centimeter

Structural Standards Committee

Convener: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

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1.0 SCOPE

This specification covers classification of soil for earthwork in excavation and filling for site grading work. Method of field density for soil compaction, using soft rock and hard rock, is also explained.

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 phawra, rake or other ordinary digging implements such as:

Sand, gravel, loam, clay, mud, black cotton soil

Vegetables or organic soil, turf, peats, soft shale or loose moorum

Mud concrete below ground level

Any mixture of soil mentioned above.

2.2 Hard/ Dense Soil

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

i) Stiff heavy clay, hard shale or compact moorum requiring grafting tool and/ or pick and shovel

ii) Shingle and river or nallah bed boulders

iii) Soling of roads, paths etc. and hard core

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

v) Lime concrete, stone masonry in lime or cement mortar below ground level

vi) Soft conglomerate when the stone can be detached from the matrix with picks and shovels

3.0 SOFT ROCK

This is fissured / disintegrated rocky strata, boulders (volume less than 0.4 m^3 and more than 0.028 M^3) 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, thinly bedded philites, 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 restored to, for loosening the materials, but this will not, in any way entitle the material to be classified as "Hard Rock".

4.0 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.

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4.2 Hard Rock (Requiring General Blasting)

This shall include all types of hard and compact rock occurring in unfissured masses or similar foundations, boulders (volume more than $0.4m^3$) for excavation in which blasting is considered necessary such as quartzite, granite, basalt stones, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

4.3 Hard Rock (Requiring Controlled Blasting)

This type of excavation becomes necessary when excavation is done in formations, mentioned in Clause 4.2, in the vicinity of existing foundations/ structures. Mode of blasting shall be decided by Engineer-in-Charge, keeping in view the sensitivity of structures.

4.4 Hard Rock (Blasting Prohibited)

Hard rock requiring blasting as described in clause 4.2 above, but when blasting is prohibited for any reason and excavation has to be carried out by chiseling, splitter or any other agreed method.

The use of excavation shall not be considered as a reason for classification under hard rock requiring blasting unless clearly found necessary in the opinion of Engineer-in-Charge.

5.0 FILLING SOIL

5.1 Ordinary soil used for filling shall meet requirements of clause 4 of Standard Spec. No. 6-65-0017, for Site Grading.

5.2 Use of soft rock for filling shall be determined based on compaction test of filling material. Well graded soft rock with sufficient fines should make a good filling material. This shall be tested in field for compaction and then density of compacted soils shall be determined. Test patches shall be made in field using this material and number of passes of rollers determined for each patch. A minimum of 3 test patches of 10m x 10m shall be made. Density of compaction shall be determined in each patch. A density of 1.90 gm/cc or more shall be acceptable.

5.3 Use of hard rock with soft rock and soil for filling shall be determined based on compaction test of rock material to be used for filling. Test patches shall be made as in case of soft rocks and number of rolls shall be determined for each test patch. Density of material in all test patches shall be found, which should not be less than 2.0 gm/cc.

5.4 The decision of Engineer-in-Charge with regard to suitability of such materials shall be final.

6.0 METHOD OF FILLING / FIELD DENSITY FOR SOIL COMPACTION

6.1 Filling With Soft Rock/ Hard Rock Soil

The earth for filling shall be rock soil mass, available from cutting areas. Filling shall be done in loose thickness of 400 mm. Voids shall be filled with smaller size material to ensure well graded and compacted fill. Watering, ramming and compacting with rollers or other suitable means as approved by Engineer-in-Charge shall be done to achieve at least 90% maximum dry density. Stones used in fill material shall not exceed 150 mm in size.

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6.2 Field Testing for Density

Each layer shall be tested in field for density and accepted by the Engineer-in-Charge, subject to achieving the required density, before laying the next layer. In the event, if it is not possible to conduct compaction test due to presence of stones, the compaction shall be determined at site by excavating a pit of size 0.5m x 0.5m x 0.3m (depth) in compacted area. The excavated soil shall be weighed. The pit shall be filled with water after laying a thin polythene sheet and weight of water so filled shall be determined. Alternatively, sand can also be used for filling the pit for determining the density.

Density of filled material shall be equal to the weight of soil / weight of water

This shall not be less than 1.90 gm/cc for soft rock and 2.0gm/cc for hard rock fill area. One test per 4000 m^2 compacted area shall be done for every layer of filling. Number of tests can be increased due to variation in quality of fill material and / or at the discretion of Engineer-in-Charge.

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STANDARD SPECIFICATION FOR SITE GRADING AND ROCK CUTTING FOR SITE GRADING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	14 08 19	REAFFIRMED AND ISSUED AS STD SPEC	AVM	AJS	RS	RKT
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2	25 06 99	REVISED & ISSUED AS STD SPEC	PKT	PCS	MMK	A SONI

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Abbreviations:

DGMS	Director General of Mines Safety
gm/cc	Gram Per Cubic Centimeter
IS	Indian Standard
NGL	Natural Grade Level

Structural Standards Committee

Convener: Mr. Rajanji Srivastava

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1.0 SCOPE

This specification and the method of measurements described thereon are applicable for earthwork involved in Site Grading & Rock Cutting.

2.0 CODES & STANDARDS

IS:2720 Part IV	Methods of tests for soils.
IS:2720 Part V	Methods of tests for soils-Part 5 :Determination of liquid & plastic limit.
IS:2720 Part VII	Methods of tests for soils Part-VII :Determination of water content – Dry Density Relation using Light Compaction.
6-65-0016	Std. specification for classification of soil for earthwork in site grading.
NOTE:-	Latest Edition of all Codes and Standards shall be followed.

3.0 GENERAL

3.1 CONTRACTOR shall maintain adequate drainage facilities at SITE at all times during the execution of work. Additional ditches, drains & such other temporary means to achieve this, over and above what is shown in the drawings, shall be provided and maintained by CONTRACTOR at his own cost.

3.2 Adequate dewatering facilities like dewatering pumps and piping etc. shall also be provided by the CONTRACTOR for this work, including dewatering during excavation etc. as required, at his own cost.

4.0 MATERIAL FOR EARTHWORK

4.1 Only soil considered suitable by the Engineer-in-charge shall be deployed 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.

4.2 The CONTRACTOR shall give the samples of soil he proposes to use for filling, along with the following characteristics of the samples, to Engineer-in-charge for approval, prior to collection and use. The tests for these characteristics shall be done in a laboratory / test house as approved by Engineer-in-charge.

i. Mechanical analysis or grain 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 VII.

4.3 The soil used for filling shall be free from boulders, lumps, tree roots, rubbish or any organic deleterious matter.

4.4 Soil having plasticity index less than 20 shall be used for filling purpose.

4.5 Soil having laboratory maximum dry density of less than 1.5 gms/cc shall not be used.

4.6 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 material, proposed to be used, for filling.

4.7 The work shall be so planned and executed that the best available soil are reserved for the top portion of Embankments.

5.0 CUTTING TREES

5.1 All trees having girth above 30 cms, which are not marked for preservation, shall be cut down and their roots dug up to a depth of 1 metre from the existing ground level.

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5.2 All holes or hollows produced by digging up roots shall be carefully filled with approved soil, including all leads and lifts, rammed and compacted to obtain 90% of maximum laboratory dry density of soil and levelled as directed.

5.3 All uprooted trees shall be stacked or disposed off as directed by Engineer-in-charge.

5.4 Payment

Cutting of trees above 30 cms girth shall be paid per number. The rate quoted shall include cutting, uprooting removing the trees within plant boundary as directed, including filling holes or hollows produced by removal of roots etc. as per specifications.

6.0 CLEARING AND STRIPPING

6.1 All the areas, including depressions, where filling or cutting is to be carried out shall be cleared and stripped completely of bushes, roots, vegetation, plantation trees, shrubs, trees upto 30 cms girth, organic and other objectionable materials. All these shall be completely uprooted and virgin soil exposed and not merely scrapped at the surface. The roots of trees of girth upto 30 cms shall be removed to a minimum depth of 1M below existing ground level and holes, hollows filled up with selected approved available soil within all leads and lifts and compacted to obtain 90% of laboratory dry density of soil as per IS: 2720, Part VII and leveled as directed by Engineer-in-charge. All soft patches must be worked out to remove soft soil and selected approved earth must be filled back and the areas (areas coming under filling) compacted to obtain 90% of maximum laboratory dry density of soil, as per IS: 2720 Part VII. The depth of stripping shall be generally 50 to 150 mm as decided by Engineer-in-Charge.

6.2 Material obtained from clearing shall be stacked or disposed off as directed by Engineer-in-charge within a lead as per directions of Engineer-in-Charge.

6.3 Payment

No separate payment shall be made for clearing, stripping and disposal of materials obtained from clearing. This shall be considered as part of cutting work in areas of cutting and filling work in areas of filling and the rates quoted under the respective items of

i. Earthwork in Excavation/ Cutting
ii Earthwork in filling (both with available earth & earth obtained from approved borrow areas), shall be inclusive of clearing and stripping with all operations described above in clause no.6 in respective areas of cutting and filling.

No separate payment shall be made for clearing, stripping and disposal of materials obtained from clearing of borrow areas for earth. This shall be considered as part of filling work in area of filling and the rate quoted under the respective items.

7.0 EARTHWORK IN EXCAVATION / CUTTING

7.1 After clearing and stripping of areas as specified above in clause No.6, spot levels at intervals and pattern as decided by the Engineer-in-charge, shall be taken jointly by CONTRACTOR and Engineer-in-charge. Excavation / cutting shall commence only after the levels are signed by the contractor as a token of his acceptance.

7.2 Excavation/ cutting shall be carried out strictly as per the instruction of Engineer-in-charge.

7.3 If the contractor excavates/ cuts beyond the required level, additional quantity of earthwork shall not be paid for. The excavation taken below the specified level shall be made good by filling with approved material, to the required compaction, at Contractor's cost.

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7.4 The final bed and sides of excavation must be levelled, dressed and compacted. In case of areas under excavation for site grading, the final surface shall be levelled, dressed and consolidated by means of sheep foot / power driven rollers to obtain maximum compaction. However, no test control is required in such areas.

7.5 Shoring and strutting shall be adopted only with the permission of Engineer-in-charge in writing. Such shoring and strutting shall follow the necessary specification.

7.6 Provisions for dewatering shall be governed by the relevant clauses.

7.7 Payment

Payment for Excavation shall be on the basis of volume of excavation calculated on the basis of joint level taken as per clause 7.1 and the final finished grade levels, the volume being calculated by the Trapezoidal rule including dewatering, if required. Intermediate payment will be on the basis of volume calculated based on spot levels taken during the time of the billing. Reference is also invited to clause 7.3.

8.0 EARTHWORK IN FILLING

8.1 After clearing, stripping and consolidation of areas as specified in clause 6, spot levels at intervals and pattern as decided by Engineer-in-charge shall be taken jointly by the CONTRACTOR and Engineer-in-Charge and filling shall commence only after the levels are signed by the CONTRACTOR as a token of his acceptance. Approved fill Material shall be spread in uniform layers not exceeding 30 cms in loose depth.

The contractor has to make his own approach and access roads from the borrow area to the demarcated filling areas. While the CONTRACTOR may make use of such short cuts as may be available to him for earth movement from borrow areas to the filling areas, the OWNER does not guarantee any passage way or right of way for the CONTRACTOR's work other than available at site. No claim shall also be admissible to the CONTRACTOR on account of his having to take longer leads or routes for earth movement, than envisaged by him, either due to any road cuttings, non-availability of routes, or any other grounds whatsoever.

In case total filling required in any area consists of soil both from borrow areas and available approved excavated material from within plant area, then joint levels, shall be taken before commencing filling with earth from borrow area.

However, earth available from borrow areas required for filling can be used only after the available earth from excavation within demarcated area has been utilised and clearance to this effect obtained from the Engineer-in-charge.

8.2 All clods, lumps etc, shall be broken before compaction.

8.3 Successive layers of filling shall not be placed until the layer below has been thoroughly compacted and tested to satisfy the requirements laid down in this specification.

8.4 Prior to rolling, the moisture content of material shall be brought to within plus or minus 2% of the Optimum Moisture Content as described in IS: 2720 Part VII. The moisture content shall preferably be on the wet side for potentially expansive soil.

8.5 After adjusting the Moisture Content as described in clause 8.4, the layers shall be thoroughly compacted by either sheep foot roller or power driven roller or vibratory roller, as approved by Engineer-in-charge, till the specified maximum laboratory dry density is obtained.

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8.6 Each layer shall be tested in field for density and accepted by Engineer-in-charge, subject to achieving the required density, before laying the next layer. A minimum of one test per 500m2 for each layer shall be conducted.

8.7 If the layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of construction altered as directed by Engineer-in-charge to obtain the required density.

8.8 The filling shall be finished in conformity with the alignment, levels, cross-section and dimensions as shown in the drawing.

Earthen embankment shall be filled 300mm more on both sides, where height is more than 1M and this extra filling shall be dressed, after compaction, in conformity with alignment, level, cross-section and dimension as shown in the drawing, to achieve proper compaction in the slope. No extra payment shall be made in this regard.

8.9 Extra material shall be removed and disposed off as directed by the Engineer-in-charge.

8.10 Tolerances

General site grading, including cutting and filling in depressions, shall be carried out to within up down tolerance of ±5 cms of final lines, grades and slopes.

8.11 Earth Work in Filling in Open Lined/Unlined Wells

For earth work in filling in open lined/unlined wells, only locally available coarse sand shall be used, in layers of 500 mm thickness. Each layer shall be thoroughly wetted by sprinkling water, before next layer is filled up. Filling shall be done upto 1m depth below NGL as above. Layers from a depth of 1m below NGL, upto NGL, shall also comprise of locally available coarse sand and compacted with suitable Mechanical / manual means, to obtain same level of compaction as required for filling above NGL. Filling above NGL shall be done as per Cl. 8.1 to 8.10 above.

8.12 Payment

8.12.1 Payment for filling shall be made on cubic metre of volume calculated on the basis of cross section plotted from the levels of ground, where filling is to be carried out and the levels reached after filling is duly consolidated, volume being calculated by Trapezoidal method.

8.12.2 In case of simultaneous cut and fill operation, wherever specified, payment shall be made on the basis of one composite rate for cutting and filling. All other details about measurement etc. remaining same as above.

8.12.3 Payment for filling in open wells, lined or unlined, shall be made on the basis of volume calculated on the basis of average area mult6iplied with depth of open well

8.12.4 No extra payment shall be made towards testing.

9.0 REMOVAL OF SURPLUS EARTH

9.1 Surplus earth and soil from excavation and general site grading shall be removed from the construction areas to the area demarcated by the Engineer-in-charge.

9.2 Payment

Payment shall be made only for lead beyond initial lead from construction area. Rate shall include loading, transportation, dumping, stacking the surplus earth and soil in the area demarcated by the Engineer-in-charge.

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Payment shall be made on cubic metre basis of the difference of measurements of the volumes of the excavation and the measurement of the filling with the excavated earth. However, the contractor's entitlement to payment shall be restricted to the actual quantity of earth removed. Quantity generated due to void in back filled volume of earth shall also be removed by the contractor at no extra cost and this disposal of earth shall not be measured and paid under any item.

10.0 EXCAVATION IN ROCK

10.1 Blasting operations shall be carried out with the prior permission and in the presence of the Engineer-in-charge or his authorised representative and during fixed time hours of the day. Blasting operations shall be carried out as per Indian Explosive Rules 1983, amended up to date. The contractor shall have a valid license from Controller of Explosives to carry out blasting operations as well as for obtaining and storing the explosives as per Indian Explosive Rules (latest). All safety precautions such as providing safety nylon netting etc. shall be carried out as per instructions of the Engineer-in-charge.

In case the contractor is not having a valid license from Controller of Explosives to carry out blasting operations and storing / handling explosives as per Indian Explosives Rules (latest). The contractor may engage an agency for blasting who is having valid license required to carry out blasting operation. Prior to start of blasting operation, contractor shall submit all the relevant licenses required for blasting operation to Engineer-in-Charge.

10.1.1 The contractor shall ensure that all workmen and the personnel at site except those who have actually to light the fuse are evacuated from the unsafe area to be determined by the Engineer and warned by loud speaker in local language to safe distance, not less than 200 metres at least 15 minutes before firing time by sounding warning siren. The area shall be encircled by red flags. The contractor shall be responsible for any accident to workmen, public or property due to blasting operation.

10.1.2 Gunpowder, gelatin and other safe explosives only shall be used wherever possible. Explosives with nitroglycerine shall be used only under exceptional circumstances, with prior approval of the Engineer-in-Charge.

10.1.3 All fuses shall be cut to the length required, before being inserted into the holes.

10.1.4 The no. of charges to be fired and the actual no. of shots heard shall be compared and the person responsible must satisfy himself by examination that all the charges have exploded before work people are permitted to approach the scene. The withdrawal of a charge, which has not exploded shall under no circumstances be permitted, such charges shall be flooded with water and the hole marked into a distinguishing manner. The next hole to be fired shall be at a distance of about 500 mm from the unexploded hole and fired in the usual way.

The contractor or sub contractor or any of his competent authorised person shall be in charge of the blasting operations and shall be held responsible for strictly observing the safety rules, particularly applicable to blasting operations, in addition to other safety rules.

10.1.5 For blasting rocks with dynamite, the following general principles shall be observed.

In general, the following diameter of drills shall be used for different depth of boreholes.

From 1-2 metres	25mm diameter
From 2-3.25 metres	37-50mm diameter
From 3.25-4.75metres	50-65mm diameter

The boreholes should generally be not more than 1.5m deep and the distance apart should be from one and a half to twice their depth.

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Cracks and fissures in the rock to be blasted shall be carefully studied to ascertain the best position for the boreholes. The charge shall always be placed in a sound piece of rock, if possible not nearer than 300mm from the crack.

10.2 Rules for Blasting with Dynamite and other High Explosives

10.2.1 The Person-in-charge must show that he is thoroughly acquainted with the blasting operations and that he understands the rules laid down herewith. He will be held responsible for any accident that may occur. He must be a licenced blaster with a valid licence from DGMS.

10.2.2 Boreholes must be of such a size and uniform that the cartridges can easily pass down them.

10.2.3 The position of all holes to be drilled must be marked out with white paint and the person-in-charge must take particular note of these positions.

10.2.4 The drilling operation after being finished, the person-in-charge must make a second inspection and satisfy himself that the boreholes marked out by him have been drilled and cleaned properly.

10.2.5 The person-in-charge must prepare all charges necessary for boreholes.

10.2.6 Number of holes to be loaded and fired at one time shall be as per explosive rules. Boreholes must be thoroughly cleared before a cartridge is inserted.

The loading is to be done by the person-in-charge himself and the position of the charge holes carefully noted by him. Circular wooden tamping rods only to be used in charging holes with flat bottom, (one cartridge at a time must be inserted) and cartridge gently pressed with the tamping rod.

10.2.7 Immediately before firing a blast, due warning must be given and the person-in-charge must see that all the labours have retired to safety.

10.2.8 The safety fuses of the charged holes are to be lighted in the presence of the person-in-charge, who must see that the fuses of the holes charged have properly ignited.

After the blast, the person-in-charge must carefully inspect the work and satisfy himself that all the charges have exploded.

10.3 Misfires

10.3.1 Misfires are a source of great danger. If it is suspected that part of the blast to fire is delayed, sufficient time shall be allowed to elapse before entering the danger zone. When fuse and blasting caps are used, a safe time of at least an hour should be allowed.

10.3.2 None of the drillers are to work near these holes until the three following operations have been done by the person-in-charge.

a. The Person-in-charge should very carefully extract the tamping with a wooden scrapper and withdraw the fuse with the primer and detonator attached, after which a fresh primer and detonator with fuse should be placed in this hole and fired; or

b. The hole may be cleared of 300mm of tamping and the direction then ascertained by placing a stick in the hole. Another hole may then be drilled 150mm away and parallel to it: this hole to be then charged and fired when the other charge should explode.

c. Drilling in holes not completely exploded by blasting shall not be permitted.

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10.4 Precautions Against Misfire

10.4.1 The safety fuse should be cut in an oblique direction with a knife.

10.4.2 All saw dust must be cleared from the inside of the detonator; this can be done by blowing down the detonation and tapping the open end. No instrument shall be inserted into the detonator for this purpose.

10.4.3 After inserting the fuse in the detonator, it shall be fixed by means of nippers.

10.4.4 If there is water present, or if the boreholes be damp, the junction of the fuse and detonator must be made water tight by means of grease, white lead or tar.

10.4.5 The detonator should be inserted into the cartridge, so that about one third of the copper tube is left exposed outside the explosives. The safety fuse outside the detonator, should be necessarily tied in position in the cartridge. Waterproof fuse only to be used in the damp boreholes, or when water is present in the borehole.

10.4.6 If a misfire has been found to be due to defective fuse, detonator or dynamite, the whole quantity or box from which the detective article was used shall be rejected.

10.4.7 Storage of materials for blasting shall be as per statutory regulations / stipulations of the concerned authorities.

It shall be the Contractor's responsibility to arrange for proper storage of explosives and obtain required permissions from concerned authorities. No separate payment shall be payable for the above.

10.4.8. **Cleaning of Excavation**

Excavation shall be cleaned, trimmed to exact shape and all disturbed material and other debris shall be removed. When the excavation have been taken out to the lines specified as shown on the drawings and the surface cleaned as specified, the contractor shall notify the Engineer that the excavation is ready for inspection and no further work shall be done with concrete or backfill until it has been inspected and approved by the Engineer. Cost of this work is deemed to have been included in the unit rates for excavation.

10.4.9. **Use of Excavation Material**

Where any material obtained from the excavation is, in the opinion of the Engineer, suitable for use in a particular section of the work as fill or backfill, such material shall be selected and if necessary, loaded, hauled, placed, spread and used to construct the fill or backfill with respect to the lines and grades specified for the work. As far as possible the most suitable of the materials excavated for the work shall be used to construct the fill and backfill embankments, roads and storage areas, where required. The useful rock available shall be stacked at the locations as decided by the Engineer and the cost of this work is deemed to have been included in the Unit rate of excavation.

Materials containing brush roots or other perishable materials shall not be considered suitable. The suitability of the materials and their disposition in the work shall be subject to the approval of the Engineer-in-Charge.

10.4.10 **Disposal of Surplus material**

All surplus materials shall be carried away from the site and disposed at dumping sites selected by the Engineer, up to a lead as indicated in the relevant items of the schedule of rates. The Engineer may ask the contractor to dump the excavated materials in regular heaps, bunds, blankets, riprap with regular slopes as directed by the Engineer and levelled so as to provide natural drainage. As a rule, all softer material shall be laid along the centre of heaps, with the harder and more weather resisting

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materials forming the casing on the sides and the top. Excavated rocks, which can be used in soling as road metals or for making concrete aggregate shall be stacked separately, as directed by the Engineer. All such works as mentioned above is deemed to have been taken into account while quoting for the excavation and the contractor for the above works shall claim no extras.

All rock excavated from the pits shall be the property of the Owner.

10.4.11 **Stock Piles**

When the removal of material from excavation progresses at a faster rate or at different times than placement in backfill is being accomplished, such excavated materials shall be stock piled at approved locations adjacent to the work until their use is authorised.

10.4.12 **Spoil Areas**

Material excavated for the works, which is rejected as unsuitable or not required by the Engineer, shall be disposed of in spoil areas as specified by the Engineer.

The spoil areas shall be left in a neat and sighty condition and sloped to drain properly as may be directed by the Engineer.

10.5 Control Blasting

10.5.1 **General**

This specification lays down the requirements for control blasting for rock excavations wherever required.

Wherever required by the Engineer, the rock blasting shall be controlled, so that vibration generated during the blasting do not cause damage to the buildings and installation around built up areas. Similarly the rock pieces should not fly off the pits and thus damage the buildings and installation around. Apart from the general precautions mentioned in the preceding paragraphs, following protective measures are suggested as guidelines. Tenderers are requested to carefully check the site conditions and submit the details of the scheme they propose to adopt for controlling the blast.

10.5.2 **Protective Measures**

a. Short delay blasting with light charges shall be used.

b. The blast hole shall be covered with 0.6 to 1.0 sqm. mild steel plate of minimum 6mm thickness.

c. Reinforcement rod mesh, not less than 20mm dia at 150mm centres in both directions, shall be put over the steel plates.

d. Steel plate and reinforcements shall be inspected after every blasting operation and all twists shall be removed before reuse, to the satisfaction of the Engineer-in-Charge.

e. The thickness of the covering plate and the kind of dead weight shall be duly got approved from the Engineer-in-Charge.

When blasting is necessary adjacent to partially or completely built structures, the contractor shall take all precautions necessary to prevent flying rock from causing damage to the structures.

In no case shall blasting be allowed closer than 15m to any structure after concrete placing has started.

The contractor shall be responsible for all damage caused by blasting, whether permanent or temporary structure and shall replace or repair the structures at his own cost.

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10.6 Classification of soil

If soil of any classifications other than that specified in the Schedule of Rates is met during excavation, the decision of the Engineer-in-charge as to the classification of soil, levels of the strata of different classifications and their locations shall be binding.

In above case, the total quantity of Excavation shall be computed from the measurement of the area excavated. The hard rock and soft rock shall be measured separately from the relevant stacks and each shall be reduced by fifty percent for voids, and paid under the relevant items. The balance, that is the total quantity of excavation minus the reduced (for voids) quantity of excavation for rocks shall be paid as soil as per the discretion of the Engineer-in-Charge. However, the maximum payment shall be limited to the volume of the area excavated, as approved by Engineer-in-charge.

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STANDARD SPECIFICATION FOR CONCRETE PAVEMENT

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
4	04 07 19	REVISED AND ISSUED AS STD SPEC	SD	GS/AK	RS	RKT
3	23 05 11	REVISED AND ISSUED AS STD SPEC	ALOK	RKS	RBB	DM
2	20 01 05	REVISED AND ISSUED AS STD SPEC	GG	SKC	VDS	SKG
1	15 7 98	REVISED AND ISSUED AS STD SPEC	PCS	RJAIN	MMK	ASONI
0	31 3 82	ISSUED AS STANDARD SPECIFICATION	RP	RPB	HVR	RCPC

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Abbreviations:

BS	:	British Standard
IRC	:	Indian Road Congress
IS	:	Indian Standard
MS	:	Mild Steel
PCC	:	Plain Cement Concrete
RCC	:	Reinforced Cement Concrete
DLC	:	Dry Lean Concrete

Structural Standards Committee

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Members:
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1.0 SCOPE

This specification establishes the requirements of material, laying and finishing of concrete pavements and roads.

2.0 REFERENCE CODES AND SPECIFICATIONS

IS: 456	Plain and Reinforced Concrete-Code of Practice.
IS: 1834	Specification for Hot Applied Sealing Compounds for Joints in Concrete.
IS: 1838, Part-1	Specification for Preformed Fillers for Expansion Joints in Pavements and Structures (Non Extruding and Resilient Type): Part 1 Bitumen Impregnated Fibre.
IS: 2720, Part-8	Method of Test for Soils-Part 8: Determination of Water Content-Dry Density Relation Using Heavy Compaction.
IS: 9214	Method of Determination of Modulus of Sub-grade Reaction (k value) of Soils in the Field.
IRC: 57	Recommended practice for sealing of joints in concrete pavement
IRC-15	Standard Specifications and code of Practice for construction of concrete roads
MoRTH	Specification for Road and Bridge Works of Ministry of Road Transport and Highways
6-68-0002	Technical Specification - Civil & Structural Works - Materials.
6-68-0004	Technical Specification - Civil & Structural Works – Plain and Reinforced Cement Concrete.
7-65-0404	RCC Pavement Details
	MoRTH Specification for Road and Bridge

In case of conflict between the Clauses mentioned in this Specification and those in above Codes and Specifications, this Specification shall govern.

3.0 MATERIALS

3.1 Material for Cement Concrete viz. Cement, Sand, Coarse and Fine aggregate and water, Reinforcements Bars, Embedment, Inserts and Admixture etc. shall be as described in EIL Specification no. 6-68-0002.

3.2 Material for DLC shall be as described Specification for Road and Bridge Works of Ministry of Road Transport and Highways (MoRTH).

4.0 GRADES, TYPE OF CONCRETE MIX, PROPORTIONING AND BATCHING

4.1 The grades of concrete shall be as per standard / Job drawing.

4.2 Specification for Concrete mix, Mix Proportioning and Batching shall be as described in EIL Specification no. 6-68-0004 and IS: 456.

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5.0 EQUIPMENTS

All equipments like sub grade templates, hand tempers, vibrating screens, internal vibrators, longitudinal floats, bridges, push brooms, straight edges, edging tools etc. shall be on the worksite in first class working condition and shall have been inspected by the Engineer-in-Charge before paving operations are permitted to start. Throughout the construction period, the contractor shall maintain adequate equipment in first class working conditions to ensure the proper execution of the work.

6.0 PREPARATION OF SUB GRADE

6.1 The area where concrete 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 95% 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.

6.2 For areas, where pavement is to be laid on cutting / natural grade level, Sub grade shall be thoroughly compacted to 95% of laboratory dry density as per IS: 2720 Part VIII. For filled up areas, top 450 mm of the soil shall be compacted to 95% of laboratory dry density below pavement in layers of 150 mm.

6.3 The difference between the sub grade levels of Type-I, Type-II, Type-III and any other type (as per job drawing) Concrete pavements (due to difference in thickness of Type-I, Type-II, Type-III and any other type pavements) shall be achieved by stripping the grade level and not by filling. Hence, site-grading level below pavement shall be kept up to sub grade level of Type-II or Type-III as the case may be, to avoid filling of smaller thickness at later stage.

6.4 The sub grade or sub base for laying of the concrete pavement shall comply with the following requirements:

6.4.1 No soft spots shall be present in the sub grade.

6.4.2 The uniformly compacted sub grade or base course shall extend at least 300mm on either side of the area to be concreted.

6.4.3 The sub grade shall be properly drained.

6.4.4 The minimum modules of sub grade in wet condition, reaction obtained with a Plate Bearing Test as per IS: 9214, shall be 6.0 Kg/cm²/cm.

6.4.5 Sub grade shall be prepared to the lines and grades to match with the slope of pavement as shown on the drawings.

7.0 PREPARATION OF SUB BASE

7.1 The construction of the Dry Lean concrete sub base for cement concrete pavement shall conform to the requirements of section 601.0 of specification for Road and Bridge Works of Ministry of Road Transport and Highways (MoRTH) and EIL standard Drg. No. 7-65-0404/ Job drawing.

7.2 Sub Base layer shall be prepared to the lines and grades to match with the slope of pavement as shown on the drawings.

7.3 No concrete shall be placed around manholes or other structures until they have been brought to required grade and alignment. All sides of manholes / pits etc. shall have same elevation.

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7.4 A separation membrane shall be used between the concrete slab and the sub base (DLC) which shall conform to EIL standard Drg. No. 7-65-0404/ Job drawing. The separation membrane shall be laid flat without creases. Before placing the separation membrane, the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheeting shall be replaced at the Contractor's expense. The separation membrane may be nailed to the lower layer with concrete nails.

8.0 FORMS

8.1 All side Forms shall be of mild steel unless use of wooden sections is specially permitted. The steel forms shall be of MS channel sections and their depth shall be equal to thickness of the pavement. The sections shall have a length of at least 3.0m except on curves, where shorter sections may be used. These forms should be provided with ample bracing and supports to prevent the springing of the forms under the concrete pressure or thrust of machinery operating nearby.

8.2 The forms should be in a sufficient number and they should not be removed until concrete has hardened sufficiently.

8.3 In case wooden forms are permitted, these shall have minimum base width of 100 mm for 150mm or lesser thick slabs and 150mm for 200mm thick slabs.

9.0 REINFORCEMENT, MIXING & PLACING OF CONCRETE

9.1 Laying of Reinforcement

All reinforcement work shall confirm to IS: 456 and as described in EIL Specification no. 6-68-0004.

9.2 Mixing

Mixing shall be as described in EIL Specification no. 6-68-0004.

9.3 Placing

9.3.1 The place where concrete is to be poured should be clean and free from all loose dirt, wooden pieces, dust, standing water etc.

9.3.2 Walking on reinforcement layers is not permissible. Walkways of wooden planks or similar material can be placed with removable supports and should be independent of the reinforcement. The reinforcement position should not be disturbed nor should it sag during carriage and placement of concrete.

9.3.3 Placing and vibration should not take totally more than 20 minutes from time of mixing. Method of placing should be got approved by Engineer-in-Charge. Segregation during carriage and placement should be avoided. If during carriage concrete segregates, it should be remixed before placement.

9.3.4 Concrete should not be dropped from a height of over 1.5m.

9.3.5 To ensure bond and water tightness between old concrete surface and fresh concrete to be placed, the surface should be cleaned and roughened by "initial green cut" by wire brushing or chipping. The initial green may be done by wire brush after 6 hours of placing concrete in order to facilitate the work. Chipping can be done only after 48 hours. A layer of cement

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slurry with 1:1 mix (1 cement: 1 sand) should be poured to obtain a uniform coating on old concrete. Immediately thereafter, the fresh concrete should be poured.

9.3.6 Concrete shall be mixed in quantities required for immediate use and shall be deposited on the sub-grade in a single operation to the required depth and width of the pavement. Spreading shall be as uniform as possible to avoid re-handling of concrete. Where however, a certain amount of redistribution is necessary, it shall be done with shovels and not with rakes. Concrete shall be vibrated with internal vibrators. Concrete shall be placed continuously until completion of the part of the work between construction joints or as directed by Engineer-in-Charge continuously until completion of the part of the work between construction joints or as directed by Engineer-in-Charge.

9.3.7 **Placing in inclement weather**

All precautions shall be taken for concreting in extreme weather in accordance with the relevant clauses of IS: 456. Due protection shall be provided to prevent cement being blown away while proportioning and mixing during windy weather. No concreting shall be carried out in continuous heavy rains. Necessary arrangements to cover the freshly poured concrete shall be provided, to protect it from the direct rays of the sun and from drying winds.

9.3.8 All concreting placement should be co-coordinated with placement of conduits, inserts, embedded parts etc. executed either by same agency or separately.

9.3.9 Concrete shall be laid in panels as shown in the standard drawing or as directed by Engineer-in-Charge.

9.4 Compaction & Finishing

9.4.1 **Compaction**

The surface of the pavement shall be compacted either by means of power driven finish machine or a vibrating hand screed. For areas where width of the pavement is very small, hand consolidation and finishing shall be done as follows:

9.4.1.1 Concrete as soon as placed, shall be struck off uniformly and screeted to the crown and cross-section shown on the plans and to such level above the base that when compacted and finished, the pavement shall conform to the grade and cross-section indicated by the plans. The entire surface shall then be tamped until a close-knit dense surface is obtained.

9.4.1.2 The Tamper shall rest on the side forms and shall be drawn ahead with a swing motion in combination with a series of lifts and drops alternating with lateral shifts. The aim of this operation is compaction and screeding to the approximate level required. Subsequent tamping should advance 75 mm at a time in the direction in which the work is proceeding and in final stages, the tamping should be closer, about 12 mm at a time, until a level and dense surface is obtained.

9.4.1.3 If so directed by Engineer-in-charge, hand operated vibrating tamper consisting of normal type of hand tamper attached to a pneumatic or electric vibrating unit shall be used for compaction.

9.4.1.4 Segregated particles of coarse aggregate, which collect in front of the tamper, shall be thrown outside the forms or thoroughly mixed by hand with a mass of concrete already on the base.

9.4.1.5 Compaction by tamping shall be carried on till the mortar in the mix just works up to the surface. The surface shall be examined after compaction correction. If needed correction shall be made by adding or removing concrete, followed by further compaction and finishing.

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9.4.2 **Floating**

As soon as practicable, after concrete has been struck off and compacted, it shall be further smoothened and compacted by means of a longitudinal float, 1200 mm long and 75 mm wide, operated from a foot bridge.

9.4.3 **Straight Edging**

After floating is completed and excess water removed but while concrete is still plastic, the slab surface shall be tested for trueness with a straight edge and rectified, if necessary.

9.4.4 **Brooming**

After belting and as soon as surplus water has risen to the surface, the pavement shall be given a broom finish to produce corrugations of uniform appearance of not more than 1/16 inch in depth.

9.4.5 **Edging**

Before the concrete has its initial set, the edges shall be carefully finished with an edger of the radius required and pavement edge shall be left smooth and true to line.

9.5 Curing

Curing of concrete shall be as described in EIL Specification no. 6-68-0004.

10.0 JOINTS

10.1 Wherever called for on the drawings, expansion joints, construction joints and sealing joints shall be provided as per details indicated in the drawing and as directed by Engineer-in-Charge.

10.2 Sealing of Joints

10.2.1 After the curing, the temporary seal or other intruded materials of all expansion and contraction joints shall be removed completely and the slots filled with approved silicone sealant. It shall be self leveling low modulus type confirming to ASTM 5893. The sealant shall conform to IRC 57. The filler material for Expansion and Sealing joints shall be preformed fillers of Bitumen Impregnated Fiber, conforming to IS: 1838, Part-I.

10.2.2 The edges of the joints shall be thoroughly cleaned and a suitable primer as recommended by sealant manufacturer shall be applied in accordance with IRC:57.

10.2.3 The application of the sealing compound shall conform to the process as specified in IRC 57.

11.0 OPENING TO TRAFFIC

11.1 Traffic shall not be allowed for a period of 28 days after laying of concrete in pavement.

11.2 Before opening the pavement to traffic, all joints shall be filled and trimmed or topped out as required.

11.3 Sampling, testing and acceptance of concrete work for pavement / road shall be according to IS: 456 / IRC -15 as applicable.

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12.0 METHOD AND BASIS FOR PAYMENT

12.1 Plain and Reinforced Concrete

12.1.1 Payment for plane and reinforced concrete in pavements shall be made on cubic metre basis of the volume of the actual finished work done and shall be inclusive of cost of providing Forms, Pockets, Chamfers, Fillets, Grooves, Cement wash, Curing by normal moist curing or using curing compound etc. as directed by Engineer-in-Charge. The rates shall be deemed to include complete cost of getting the respective mix designs approved, making and testing concrete cubes and carrying out other tests including tests of various ingredients, as per specifications and as directed by Engineer-in-Charge.

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

12.1.3 The rate shall however be exclusive of reinforcement, metal inserts, pipe sleeves and any filler material in expansion / sealing joints.

12.1.4 Where the strength of concrete mix (nominal or design mix) as indicated by tests, lies in between the strengths of two grades given in Table-1 of EIL Specification No. 6-68-0004 and it is accepted by owner/Engineer-in-charge, such concrete shall be classified as a grade belonging to the lower of the two grades between which it lies. In case the cube 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. The concrete giving lower strength than specified may be accepted at reduced rates after satisfying the safety of the structure by checking it with tests as specified or rejected entirely at the discretion of the Engineer-in Charge. 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 and 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. In case the concrete of lower strength can be improved by carrying out some strengthening measures entirely at the discretion of the Engineer-in-Charge, then Contractor shall carry out the said measures including all related tests at his own cost. If the Contractor is able to make up the strength to the required grade by such improvement measures to the entire satisfaction of Engineer-in-Charge, payment shall be made for the grade achieved. However, if the strength of concrete is not made up to the strength of required grade, payment shall be made only for the lower strength if such concrete is accepted by the Engineer-in-Charge.

12.1.5 Deductions for openings, pockets etc. shall be as specified in relevant Indian Standard Codes.

12.2 Reinforcement

12.2.1 Payment for plain round mild steel reinforcement bars and high strength deformed steel bars shall be on the basis of weight of bare steel, irrespective of any coating applied, in metric tons. The weight of the bar shall be derived from the sizes and corresponding unit weights given in hand book of Bureau of Indian Standards. Standard hook length, chairs, spacer bars and authorised laps 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.

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

12.3 Joints

Payment for expansion joints, construction joints and sealing joints shall be made on running metre basis. The rate shall include cleaning of joints, filler material and sealing with approved compound, all material, labour etc. complete, as per drawing.

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STANDARD SPECIFICATION FOR PIPE CULVERTS & ERC/ IRC CROSSING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	14 03 19	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	AVM	AJS	RS	RKT
3	23.05 11	REVISED & ISSUED AS STD SPEC	AS	RKS	RBB	DM

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Abbreviations:

ERC	:	Electrical Road Crossings
IRC	:	Instrumentation Road Crossings
IS	:	Indian Standard
PVC	:	Poly Vinyl Chloride
RCC	:	Reinforced Cement Concrete

Structural Standards Committee

Convener: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
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1.0 SCOPE

The scope of this specification covers RCC pipe culverts and ERC/ IRC crossings with RCC or PVC pipes.

2.0 CODES & STANDARDS

IS: 458	Precast Concrete Pipes (with and without reinforcement)
IS: 783	Code of practice for laying of RCC pipes
IS: 4985	Unplasticised PVC pipes for potable water supplies
NOTE: -	Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIALS

3.1 All pipes must be new and perfectly sound, free from cracks, cylindrically straight and of standard nominal diameter and length, with even texture. PVC Pipes shall be Class-I as per IS: 4985.

For pipe culverts, class of RCC pipe shall be NP3 / NP4 or as mentioned in the drawings.

3.2 The Contractor shall submit manufacturer's test certificate for acceptance of RCC/PVC pipes.

3.3 Spun yarn for pipe joints shall be of best quality. It shall be free from dust etc.

4.0 TRANSPORTATION AND STACKING

4.1 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.

4.2 The pipe shall be protected during handling against impact, shocks and free fall to avoid cracks and damage.

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

4.4 Earthwork

Refer standard specification No.6-68-0003 for earthwork.

5.0 LOWERING AND LAYING OF RCC PIPES

5.1 General

The laying and jointing of RCC pipes shall confirm to IS: 783.

The trench shall be checked for proper level, grade and alignment before lowering the pipes.

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5.2 Lowering

The RCC pipe shall be lowered cautiously to prevent disturbance to the bed and sides of the trench. The heavy RCC 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.

5.3 Laying

5.3.1 Laying of RCC pipes shall proceed up grade of slopes.

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

5.3.3 The end of RCC 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 RCC pipe, for its entire length, shall rest on an even bed in the trench.

5.4 Jointing of RCC pipes.

5.4.1 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.

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

5.5 Curing.

The Cement mortar joints in RCC pipes shall be cured at least for seven days.

5.6 Testing.

All joints in culvert pipelines shall be tested to a head of 1.5 m of water above the top of the highest pipe, if required, by Engineer-in-Charge.

5.7 Payment

Payment shall be made on running meter basis, which includes supplying, transporting, lowering, laying, jointing and curing, concreting around RCC pipes etc., all complete.

6.0 LOWERING AND LAYING OF PVC PIPES

6.1 Lowering and laying of PVC pipes shall be done as per IS: 4985. The jointing of the pipes shall be done by expanding one end after heating and using solvent cement.

6.2 Payment

Payment shall be made on running meter basis of PVC pipes, which includes supplying, transporting, lowering, laying and jointing, concreting around PVC pipes etc., all complete.

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STANDARD SPECIFICATION FOR UNDERGROUND & ABOVE GROUND G.I. PIPELINE SYSTEM (WATER SERVICES)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convenor	Approved by: Standards Bureau Chairman
5	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI
4	10.07.12	REVISED & ISSUED AS STD. SPEC.	JAI KUMAR	RC	RBB	DM

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Abbreviations:

GI	Galvanised Iron
IS	Indian Standard
Kg/cm^2g	Kilogram per Square Centimeter Guage

Structural Standards Committee:

Convenor: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
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Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

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1.0 SCOPE

This specification covers the fabrication and erection of GI pipeline system, both underground and above ground, including excavation, backfilling for the pipeline and testing of completed system.

2.0 CODES AND STANDARDS

IS: 554	Dimensions for pipe threads where pressure tight joints are made on threads.
IS: 778	Copper alloy gate, globe and check valves for water works purposes.
IS: 1239 Part I	Mild steel Tubes, Tubular and other wrought steel fittings.
IS: 1239 Part II	Mild steel Tubes, Tubular and other Wrought Steel fittings. Mild steel Sockets, Tubular and other Wrought steel pipe fittings.

NOTE: -Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIALS

a) All G.I. piping shall conform to IS: 1239 part I.
b) All gun metal valves shall conform to IS: 778 Class II.
c) All G.I. fittings shall conform to IS: 1239 Part II.

The schedule of pipes & fittings shall be as per schedule of items under respective works.

4.0 EARTHWORK IN EXCAVATION AND BACKFILLING ETC.

All earthwork for GI lines shall be governed by the provisions of EIL specification 6-65-0006,"Earthwork for underground piping", to the extent applicable. All earthwork in excavation, backfilling and transportation are included in the quoted rates.

5.0 JOINTING AND ERECTION OF GI PIPING SYSTEM

5.1 Screw socket Joints.

The screwed end of all GI pipes shall be thoroughly cleaned and painted with a mixture of Red and White Lead or Teflon before jointing. The joint shall be made by winding a few threads of hemp round the ends of tubes and then screwing them into sockets to the full depth of threads. Exposed threads shall be coated with approved anticorrosive paint. No pipe shall be bent / offset to save fittings. The offset in GI pipes shall be made only after the permission of the Engineer-in-Charge. If threaded end of pipe is damaged, the contractor shall cut the end with hacksaw and shall prepare new threads conforming to IS: 554, to required length.

All fittings shall be malleable Galvanised Iron approved by the Engineer-in-charge. Fitting in GI line shall include all couplings, elbows, tees, bends, unions, nipples, reducers, flanges with nuts and rubber insertion and all other fittings to make a complete job.

5.2 Flanged Joints

Flanged joints shall be made by painting the faces of the flanges with red lead and bolting up evenly on all sides with compressed asbestos gasket as per piping material specification.

5.3 Valves

Flanged or screwed valves shall be installed in locations shown on the drawings as per specification for screwed or flanged joints.

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6.0 TESTING

All completed GI piping shall be hydrostatically tested to a test pressure equal to one and a half times the working pressure, as per job requirement (Minimum test pressure shall be $6Kg/Cm^2$ g) and the test pressure shall be maintained without loss for at least 30 minutes. Pipes or fittings which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

7.0 PAYMENT

7.1 Payment shall be made on running meter basis of finished pipeline with fitting after testing etc. complete. No separate payment shall be made for earthwork in trenching and backfill, road cutting etc. Payment for valves and flanges etc. shall be made as per schedule of items on unit rate basis. The unions shall be provided at every 50 meter, unless otherwise stated in schedule of items / construction drawing. Rates shall include all incidental work such as transportation of all materials from Owners stores, custody, and fabrication and laying of GI piping system.

7.2 The payment clause 7.1 is not applicable in case of LSTK Jobs

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STANDARD SPECIFICATION FOR FABRICATION AND LAYING OF UNDERGROUND PIPING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
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6	25.11.24	REVISED & ISSUED AS STD. SPEC.	GS	GYAS	S K NASKAR	M NANDI
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4	20.05.13	REAFFIRMED & ISSUED AS STD. SPEC.	RBT	RKS	RBB	DM

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Abbreviations:

ASME	AMERICAN SOCIETY FOR MECHANICAL ENGINEERS
dia.	DIAMETER
IS	INDIAN STANDARD
Kg/cm^2/minute	KILOGRAME/SQUARE CENTIMETRE/MINUTE
m	METRE
mm	MILLIMETRE
CS	CARBON STEEL

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1.0 SCOPE

This specification covers the technical requirements for the execution of Piping Fabrication, Assembly, Laying and testing of the underground pipe work defined here under, for water and waste pipe lines.

i. Fabrication and erection of underground piping systems from piping materials in accordance with this specification and applicable drawings and standards.

ii. Fabrication and welding of reinforcement pads at branch pipe locations wherever required.

iii. Corrosion protection coating of underground piping.

iv. Repair of damaged corrosion protection coating and coating of field joints.

v. Fabrication and erection of drain assemblies, valves, strainers, instrument connection, flushing connection etc.

vi. Testing and flushing.

Underground piping systems shall be fabricated, installed, flushed, and tested in accordance with this specification and applicable codes, drawings and standards.

2.0 CODES & STANDARDS

ASME B31.3	Chemical Plant and Petroleum Refinery Piping.
6-65-0006	Standard specification for earth work for U/G piping.
6-44-0012	Standard specification for fabrication and erection of piping.
6-44-0013	Standard specification for inspection, flushing and testing of piping systems.
6-44-0016	Standard specification for Nondestructive examination requirement of piping
6-77-0001	Welding specification for the fabrication of piping
6-77-0005	Welding specification charts for piping classes
6-79-0011	Standard specification for corrosion protection tape coating for underground steel piping
6-79-0020	Standard specification for surface preparation and protective coating
6-71-0044	Standard specification for field joint coating (onshore pipeline)
6-71-0048	Standard specification for repair of polyethylene coating
----------	Job specification for 3LPE pre-coated pipes

NOTE 1: Latest Edition of all Codes and Standards shall be followed.
NOTE 2: In case job specification is available, same shall be followed.

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3.0 FABRICATION

3.1 The contractor shall fabricate all the pipe work in conformity with the Job/ Standard Specification for fabrication & Erection of Piping, and requirements of relevant general arrangement drawings/ isometrics. Where specific details of fabrication are not indicated on the drawings or not specified in the specification, fabrication and erection shall be done in accordance with ASME B 31.3.

3.2 The contractor shall be responsible for working to the exact dimensions as shown on the drawings, irrespective of individual tolerances permissible. Where errors and / or omissions occur on the drawings, it shall be the contractor's responsibility to notify the Engineer-in-Charge, prior to fabrication or erection. Dimensional tolerance for fabrication shall be as per EIL standard.

4.0 COATING & LAYING OF UNDERGROUND PIPING

4.1 Coating (for uncoated pipe)/ repair of coating (for pre-coated pipes & fittings)

Corrosion protection tape coating/ Painting of the underground lines shall be in accordance with Job/ Standard specification.

Repair of 3LPE coating of pre-coated pipes if required shall be as per Job/ Standard specification.

4.2 Laying

4.2.1 The Contractor shall lay the underground piping in accordance with the following clauses and as per the piping arrangement drawings and/ or isometrics issued during the course of construction.

4.2.2 The Contractor shall be responsible for alignment as per the drawing. Errors, if any, shall be rectified by the Contractor at his own cost.

4.3 Trenching

4.2.1 The trench shall be cut according to the drawing, true to the line, levelled with the help of sight rails provided at every 30 m, at change of direction / gradient and at any suitable distance, as directed by Engineer-in-Charge. The bottom elevation of pipe shall be maintained as shown in drawing

4.2.2 The width of the trench shall be sufficient to give free working space on each side of the pipe. The free working space shall conform to specifications. Generally, it shall not be less than 150 mm on either side or 1/3 of dia of pipe, whichever is greater.

4.2.3 If the trench is excavated below the required level as indicated in the drawing, the extra depth shall be filled with PCC 1:5:10 or approved equivalent material, as directed by the Engineer-in-Charge, at no extra cost to owner.

4.2.4 No excavated material shall be deposited within 1.5 meters from the excavated trench.

4.2.5 In case of road cutting, all materials i.e. metal, bricks etc., shall be taken out carefully and kept separately for reuse. Road work shall be redone up to the original level and profile with the excavated road materials /fresh material if required, after laying and testing of the pipe line, within 10 days from the date of starting the work, at the cost of the contractor. The contractor shall provide suitable slings and barricades to prevent accidents. He shall also provide reasonable by-pass at his own cost when a road is cut for laying pipeline.

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4.2.6 During excavation, if some obstacle is met with, the same shall be reported to the Engineer-in-Charge and dealt with as instructed by him.

4.2.7 The contractor shall do dewatering, shoring, strutting / timbering if required or do whatever might be required to excavate the trench, install the pipe in it and backfill the trench, in accordance with the specifications, at no extra cost to the Owner. Dewatering shall be done in advance of the laying of the pipe, to allow adequate inspection of padding of the bottom, if required. Dewatering shall be continued throughout during laying of the pipe and backfilling of the trench.

4.2.8 In muddy / slushy ground, the bed shall be provided with a layer of sand or lean concrete as directed by the Engineer-in-Charge.

4.2.9 The trench shall follow the gradient of pipeline as specified in the drawing. The contractor shall keep the trench in good condition, until the pipe is laid and tested. No extra claim shall be entertained due to its caving or settling down, either before or after the pipe is laid. All materials to shore the trench, in order to prevent caving, shall be furnished and removed by the Contractor, at no extra cost to the Owner.

4.2.10 In case pipe is lowered in caved trench and back filled before inspection by the Engineer-in-Charge, the Contractor shall re-excavate the trench for inspection and backfill it at his own cost.

4.3 Lowering & Laying

4.3.1 The pipe shall be lowered by mechanical method when the trench is ready and bottom of the trench is graded as per required pipe laying conditions and specifications.

4.3.2 By Machine

The shop coated pipe already transported to the pipe laying site in convenient length of pipe assembly, near the trench after hydrostatic testing, shall be placed on clean square cut skids suitably spaced, so as to keep the pipe away from touching the ground. The pipe may be lowered down in the trench by the launcher cranes with sufficient care, to protect the coating of the pipeline.

At tie in welds and other site fabrications, the contractor shall clean, prime, coat and wrap manually.

Also, short sections of pipelines, which are impracticable to shop-treat, may be hand treated, but only after obtaining prior written approval of the Engineer-in-Charge.

4.3.3 By Hand

Only in unavoidable circumstances and after obtaining approval of Engineer-in-Charge, the pipe may be lowered with the help of tripods and chain pulley blocks into the trench. However, if in the opinion of the Engineer-in-Charge, the temperature condition does not allow direct lowering, then the pipes shall be set down on clean square cut skids. The skids shall be so spaced as to keep the pipe away from touching the ground.

4.4 Method & Time of Lowering Pipe

4.4.1 Under favorable temperature conditions and using methods, which will not damage the coating, the pipe may be lowered into the trench.

4.4.2 Pipes previously set on skids, because of unfavorable temperature conditions, shall be lowered into the trench normally in the cool of the morning and only when the temperature of the pipes is below the softening point of the coating materials.

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4.4.3 All skid marks and other places of damage shall be thoroughly examined to ensure proper patching where necessary, before the pipe is finally lowered into the trench.

4.5 Handling Coated Pipe

4.5.1 Coated pipe shall not be placed in trench, until cave-in plugs, hard clods, stones, skids and welding rods etc. have been removed from there. Where the trench has a hard or jagged bottom, sufficient fine dirt or sand shall be placed therein, before the pipe is lowered.

4.5.2 Coated pipe shall not be handled or moved by means of cable or chains or by prying with skids or bars. It shall be tied and lowered by using lowering-in belts of a standard width and design, for the size of pipe being handled.

4.5.3 Coated pipe shall not be dragged along the ground or otherwise handled in a manner that will be detrimental to the coating.

4.5.4 Despite all precautions taken during handling of coated pipes, if the coating gets damaged, same shall be recoated by Contractor at site, at his own cost, as per directions of Engineer-in-Charge.

4.6 Lining up & Welding

4.6.1 The ends of the pipeline shall be kept securely closed, to prevent entry of any foreign material/ moisture, after lowering into the trench.

4.6.2 Before making joints, the pipe shall be laid carefully, so as to be perfectly aligned, in both plan and profile and the end closures provided shall be removed.

4.6.3 Tie-in shall be made in the coolness of the morning or when the ambient temperature is not exceeding 29^0C or softening temperature of the coating material, whichever is less. All bevelling, aligning and welding shall be in accordance with the welding specification given in the tender.

4.6.4 Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side, so that good welded joint is obtained.

4.7 Coating of field welded joints

Field welded joints shall be coated as per Job/ Standard specification. Field joints of externally 3LPE pre-coated pipes shall be coated as per Job/ Standard specification.

4.8 Back Filling

4.8.1 After testing and inspection of the pipeline to the entire satisfaction of the Engineer-in-Charge, the trench shall be back filled with the serviceable soil excavated earlier. No trench shall be back filled without the approval of the Engineer-in-Charge.

4.8.2 Backfilling with the serviceable soil excavated earlier shall be done in layers of 200 mm, well watered and rammed to avoid any settling afterwards.

4.8.3 The earth cover up to 300 mm above the top of the pipe shall be compacted by manual methods, to protect the pipe from any damage by mechanical compactor.

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4.8.4 If due to exigencies of the work, some portion of the pipeline is backfilled without approval of the Engineer-in-Charge, the Engineer-in-Charge shall have the right to order uncovering of the pipe for examination and the cost of such uncovering shall be borne by the Contractor.

4.8.5 The backfill material shall be free from stone pieces/sharp objects/debris.

4.8.6 When the trench has been dug through roads, all backfill shall be thoroughly compacted. In certain cases, special compaction methods may be required by the Engineer-in-Charge. This shall be done by the contractor at no extra cost to the Owner.

4.8.7 When the trench has been dug across unlined ditches, the backfill shall be thoroughly compacted in 150 mm layers for a distance of 1.5m beyond the outside banks of the ditch on either side. The banks of the ditch shall also be compacted in 150mm layers, at no extra cost to the Owner.

4.8.8 After the roads have been already graded, and if they are trenched or otherwise disturbed by the Contractor during laying of the pipe lines, the contractor shall restore the road to its original level and condition. In the event the Contractor is required to place extra fill, gravel, or other special materials, it shall be done by the contractor without any extra cost to the Owner.

4.8 Clean up of Surroundings

4.9.1 As soon as the backfill is completed, the contractor shall immediately clean up the adjoining area by removing all surplus and defective material and dispose off all refuge such as spurs, sheet-iron and broken skids and surplus excavated earth etc., at his own cost, to the entire satisfaction of the Engineer-in-Charge.

4.9.2 The earth on both sides of the pipeline trench, which has been disturbed during the construction of the pipe line, shall be smoothened and left in a condition to the entire satisfaction of Engineer-in-Charge.

5.0 INSPECTION & FLUSHING

Inspection and flushing of the piping shall be done as per Job/ Standard specification (Specification for inspection, flushing and testing of piping system).
Non-Destructive examination of shop/ field fabricated piping shall be as per Job/ Standard specification (Specification for non-destructive examination requirement of piping).

6.0 TESTING

6.1 Pressure Piping

Pressure testing of pressure piping shall be done as per Job/ Standard specification (Specification for inspection flushing and testing of piping system). Test pressure shall be as per line list/ AFC document.

6.2 Gravity/ Non-pressure Piping

6.2.1 Fabrication yard/ facility

All piping sections fabricated at yard, shall be tested in conformance to Job/ Standard specification (Specification for non-destructive examination requirements of piping). In addition to the above, each fabricated section shall be leak tested at atmospheric pressure for water tightness of the fabricated section. Any repair of coating (internal/ external) at joint location shall be carried out only on

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completion of inspection of leak test and subsequent repair of joint, if any. Care shall be taken during transportation of tested pipes for integrity of tested joints.

6.2.2 In-situ fabrication and erection

All piping including sub headers and headers fabricated/ joined and laid in-situ, shall be tested in conformance to Job/ Standard specification (Specification for non-destructive examination requirements of piping). In addition to the above, each fabricated section: piping upstream of a manhole/ between any two manholes/ sump inlet and upstream manhole shall be considered as a single system and each such system (defined in concurrence with Engineer-In-Charge) shall be leak tested at atmospheric pressure for water tightness of the fabricated section. Any repair of coating (internal/ external) at joint location shall be carried out only on completion of inspection of leak test and subsequent repair of joint, if any.

6.3 Leak Test

6.3.1 Fabrication yard/ facility

The pipe section as fabricated, from the funnel to end of transportable length shall be temporarily blanked and filled with water so that water level is up to the top of the funnel. The entire section shall be kept filled for 4 hours.

The drop in water level of all water and sewage (sanitary, chemical and industrial drainage and other gravity sewers) piping being leak tested shall be recorded at end of 4 hour at the funnel. The value so recorded shall represent a total leak test of the section (Pipe/ group of pipes). The total leak observed shall be limited to the evaporation loss for the open funnel. During test, all funnels but for the observation manhole shall be kept sealed and the observation funnel shall be provided with a temporary cover. During leak test, all exposed pipe, joints, fittings, valves, shall be carefully examined for leakage. Leaking pipes, joints, and fittings shall be replaced/repaired.

The hydrostatic test shall be repeated after the repair of any defects until the system is proved satisfactory. The piping shall be satisfactory if there is no evidence of leakage after the 4 hours.

The contractor shall undertake repairing and testing of the joint without any extra cost to the owner. After completion of the test, all temporary covers shall be removed, the test water shall be drained / pumped out and the line cleaned properly.

6.3.2 In-situ fabrication and erection

The pipe system as defined, upstream of a manhole/ between any two manholes/ sump inlet and upstream manhole shall be filled with water so that water level is up to the top of the manholes. The entire system shall be kept filled for 24 hours.

All water and sewage (sanitary, chemical and industrial drainage and other gravity sewers) piping and retaining structures under atmospheric pressure such as manholes, sumps, catch basins etc. being leak tested shall be topped up with Water to the brim after initial 8 hours and then the drop in water level shall be recorded every 4 hours at the observation manhole. The value so recorded shall represent a total leak test of the system (Pipes and Manhole). The total leak observed shall be limited to the evaporation loss for the open system of Pipes funnels and manholes. During test, all manholes and funnels but for the observation manhole shall be kept sealed and the observation manhole shall be provided with a temporary cover. Site testing shall take place prior to backfill. During hydrotest, all exposed pipe, joints, fittings, valves, shall be carefully examined for leakage. Leaking pipes, joints, and fittings shall be replaced/repaired.

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The hydrostatic test shall be repeated after the repair of any defects until the system is proved satisfactory. The piping shall be satisfactory if there is no evidence of leakage after the 24 hours.

The contractor shall undertake repairing and testing of the joint without any extra cost to the owner. After completion of the test, all temporary covers shall be removed, the test water shall be drained / pumped out and the line cleaned properly.

Before commissioning, the cleanliness of the pipeline shall be checked by following test.

Ring Test (Manhole to Manhole)

In this method of testing, two steel / wooden rings of suitable thickness and design shall be fixed facing each other, at a distance of 2 feet or more. The block of rings shall be inserted from one end of the pipeline, inside manhole and pulled by a rope fixed to the block from the other end of the pipeline, inside the next manhole. The rings shall be of dia. 2" less than the inside dia of pipe under testing. The rope used for pulling the ring block may be inserted in the pipeline by the contractor either during construction or afterwards by suitable means. Any obstruction/ debris/ major misalignment will prevent the ring to pass through the pipeline in which case the pipeline shall again be cleaned / rectified and the test redone. The ring test shall be performed for the complete network of the sewer system, before the same is put in service.

8.0 PAYMENT

8.1 Payment for Piping fabrication and erection shall be made based on respective rates. Payment of piping fabrication shall be based on inch dia. measurement whereas payment for erection of piping shall be based on inch meter measurements, calculated on the basis of the execution drawings. The length shall be measured along the center lines of pipes, center lines of bends and elbows, tees, reducers and flanged joints. All types of valves shall be excluded from this measurement. Branch connections shall be measured from the outer surface of the header.

The payment shall be made on per inch metre basis of piping work laid, measured to the nearest centimeter. The unit rates for the underground piping shall be inclusive of earthwork in excavation, backfilling, compaction, disposal of surplus earth and corrosion protection coating/ coating of field joints of 3L PE pre-coated pipes including supply of materials.

All piping attachments, such as couplings, nipples, thermowells etc., shall be installed by the Contractor as part of piping work and no separate payment shall be made for such work. However, extension on such attachments such as vents and drains will be measured and paid as applicable for the respective size and category of piping / valves.

Fabrication of mitre bends, concentric and eccentric reducers fabricated from pipes supplied by owner & fabrication of flanges from plates supplied by owner, will be paid at respective unit rates. However, erection of these items will be along with piping of the respective size and no separate payment will be made for erection.

The reducers will be measured and paid along with the piping of large diameter.

Payment of Reinforcement pads for branch connections shall be made as per respective SOR rates.

Fabrication, installation and removal of temporary spool pieces etc. to aid contractor's work such as fabrication, erection, flushing and testing etc. will neither be measured nor paid separately. The same is deemed to be included in the unit rates for piping. Payment for carrying out radiographic examination shall be based on inch dia. of joint radiographed. Repeat radiography / additional

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radiography required due to contractor's faults / poor performance of his welders and defective films etc., shall be done at contractor's own cost.

8.2 The payment clause(s) as described in the clause no. 8.1 shall not be referred / applicable for LSTK Jobs

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STANDARD SPECIFICATION FOR UNDERGROUND SEWER SYSTEM (PRE CAST RCC PIPES)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	12.03.24	REVISED & ISSUED AS STD. SPEC.	PREETI	RKS	SKN	MAINAK NANDI
4	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI

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Abbreviations:

IS	:	Indian Standard
Litres/km/hr/cm	:	Liters/ Kilometer/ Hours/ Centimeter
RCC	:	Reinforced Cement Concrete
mm	:	millimeter
cm	:	centimeter

General Civil Standards Committee:

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Members:
Mr. C. Damodaran
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Mr. Gyasuddin
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Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)
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1.0 SCOPE

This specification covers the supply, laying, cutting, jointing and testing of Precast RCC pipes and related works.

2.0 CODES & STANDARDS

IS: 458 Pre Cast Concrete Pipes (with and without reinforcement- specification)

IS: 783 Code of practice for laying of Concrete Pipes

6-65-0006 Standard Specification for Earth Work for Under Ground Piping

NOTE:- Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIALS

3.1 The pipes shall be centrifugal cast concrete pipes, socket and spigot type, with reinforcement conforming to IS: 458. The class of pipes shall be as specified on drawings. The pipes shall be accepted on the basis of Test Certificates from Manufacturers. Additional testing shall be done, if directed by Engineer-in Charge.

3.2 The surfaces and edges of the pipes shall be well defined and their ends shall be perpendicular to longitudinal axis

4.0 EARTHWORK

4.1 All earthwork involved in laying of RCC pipes and related works is deemed to have been included in the quoted rates for the laying of RCC pipes.

4.2 All earthwork shall be carried out as per specification No.6-65-0006 "Earthwork for underground piping ".

4.3 The bed of trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layers.

4.4 If the trench bottom is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade, by filling with selected fine earth or sand (fine murrum, if fine sand or soil is not available) and compacted, so as to provide smooth bedding for the pipe.

Where excavation requires blasting operations, it shall be ensured that no pipes are stacked in the vicinity and complete pipelines in the vicinity have already been covered before starting of blasting operation.

4.5 The trench shall be kept free from water. Shoring and strutting / timbering shall be done, wherever required. Excavation below water table shall be kept dry by dewatering the trenches, if required.

4.6 After excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrels of the pipes shall rest throughout their entire length on the solid ground and that sufficient spaces left for jointing the underside of the pipe joint. These hollows shall be refilled with sand after jointing the pipe.

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5.0 LOWERING & LAYING

5.1 The pipes shall be lowered when the trench is ready and the bottom has been properly graded as per drawings.

5.2 Before lowering, the pipes shall be inspected carefully. Broken or cracked pipe shall be rejected. The inside of the pipe shall be cleaned off from sand, earth or any other matter.

5.3 The pipe shall be lowered carefully so as not to disturb the bed and sides of the trench. Heavy pipes shall be lowered with chain pulley blocks or crane.

5.4 Pipes shall be set according to line and grade. Prior to making joints, all surfaces shall be thoroughly cleaned and prepared as required, for the type of joint to be made. Pipe shall be carefully centered so that the complete sewer will have a smooth uniform invert.

5.5 In socket & spigot pipes, the socket end shall face the upstream direction.

5.6 Railway authorities or other appropriate authorities shall be consulted wherever the pipeline crosses a railway line, canal, etc.

5.7 Connection to existing sewer shall be done through a manhole.

5.8 The ends of the pipeline shall be kept sealed to prevent entry of any foreign materials. The seals shall be broken before / after the testing is done.

5.9 Wherever the joining material is cement, six or more lengths of pipe shall be laid in advance of each joint before it is finished.

5.10 In cases, where the natural foundation is inadequate, the pipes shall be laid either in concrete cradle supported on proper foundations or any other suitably designed structure. If concrete cradle bedding is used, the depth of concrete below the bottom of pipe shall be at least 1/4th of the internal diameter of the pipe subject to the min. of 100 mm and a maximum of 300 mm, the concrete shall extend by 150 mm on each side beyond the outside diameter of pipes. The pipes shall be laid in this concrete bedding before the concrete has set.

Pipes laid in trenches in earth shall be bedded evenly and firmly and as far as possible, up the haunches of the pipes, so as to safely transmit the load expected from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under and around the curve of the pipe from an even bed. Necessary provision shall be made for joints, wherever required.

6.0 JOINTING

6.1 Joint in the pipeline shall be of socket and spigot type and conforming to relevant Indian standards.

6.2 As per IS: 458, only flexible rubber ring joints shall be used for the joints in (a) all pressure pipes and (b) all non- pressure pipes except when used for road culverts/ cross drains. The pipe joints shall be capable of withstanding the same pressure as the pipe. Contractor shall provide pipes of socket and spigot type, meeting the above requirements.

6.3 As per IS: 458, joints in pipes of diameter up to 700 mm, shall be external flush type joint and shall be internal flush type for pipes of diameter more than 700 mm.

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6.4 The groove in between the pipe ends is to be filled with jute, impregnated with bitumen and rolled in the form of gasket ring centrally around the pipe, to ensure uniform annular space between the collar and the pipe.

6.5 Cement mortar of proportion 1:2 shall be used for caulking the annular space. Care shall be taken to see that the bottom of the collar joint is also caulked properly.

6.6 The joint shall be finished at an angle of 45° and shall be kept wet for 10 days for curing.

7.0 TESTING

7.1 The pipeline shall be tested for water tightness of joints. The test shall be carried out from manhole. Pipe ends shall be closed and filled with water so that water level is up to the top of the manholes.

7.2 The line shall be kept full for 24 hours. Observations shall be taken at one hour interval and if leakage is within 2.5 liters/km/hr/cm of diameter of pipeline, it shall be deemed to have passed the test.

7.3 Engineer-in-Charge may at his own discretion, ask the contractor to test the laid pipe line in sections, in which case the contractor will do the same, as per the procedure to be decided by the Engineer-in-Charge, without any extra cost to Owner. The procedure adopted in such cases, however, will be to test the pipeline according to the criteria mentioned above.

7.4 In case joints are found to leak, they shall be repaired or redone and test shall be repeated until the joints are approved by Engineer-in-Charge.

The work shall have deemed to be rejected, in case any visual leakage observed from any of the joint. The contractor shall undertake repairing and testing of the joint without any extra cost to the owner.

7.5 After completion of the test, all temporary seals shall be removed, the test water shall be drained / pumped out and the line cleaned properly.

7.6 Before commissioning, the cleanliness of the pipeline shall be checked by following tests.

7.6.1 Torch & Mirror Test

In this method of testing, a torch will be held at one end of the pipeline inside a manhole and its image through the pipeline will be reflected and seen on a mirror held at the opposite end of the pipeline, inside the next manhole. Any obstruction / debris / major misalignment will not give a clear image, in which case the pipeline shall again be cleaned, rectified and the test redone.

7.6.2 Ring Test

In this method of testing, two steel / wooden rings of suitable thickness and design shall be fixed facing each other, at a distance of 2 feet or more. The block of rings shall be inserted from one end of the pipeline, inside manhole and pulled by a rope fixed to the block from the other end of the pipeline, inside the next manhole. The rings shall be of diameter 2"(inch) less than the inside diameter of pipe under testing. The rope used for pulling the ring block may be inserted in the pipeline by the contractor either during construction or afterwards by suitable means. Any obstruction/ debris/ major mis-alignment will prevent the ring to pass through the pipeline in which case the pipeline shall again be cleaned / rectified and the test redone.

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The ring test shall be performed for the complete network of the sewer system, before the same is put in commission.

8.0 RESTORATION OF DAMAGED SURFACES AND CLEARING THE SITE

8.1 All pavements, structures, pipelines, cables, etc. removed, damaged or disturbed during the pipe laying work shall be restored to original conditions.

8.2 Surplus excavated soil or rubbish material shall be removed to a place, as directed by Engineer-in-Charge.

9.0 PAYMENT

9.1 Measurement of pipeline work for the purpose of payment shall be taken in running metre of the laid pipe measured along centre line, inclusive of joints. The rate quoted shall be inclusive of excavation, lowering, laying, jointing, connecting the pipe to manholes and grouting the pipe to manhole wall, testing, cleaning of pipelines, backfilling, commissioning and any other operation involved in the pipeline work.

9.2 The payment clause(s) as described in this standard specification shall not be referred/ applicable for LSTK Jobs.

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के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR

ACID RESISTING BRICK / TILE LINING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	16.08.21	REVISED & ISSUED AS STD. SPEC.	ADP	GYAS	ANURAG SINHA	SANJAY MAZUMDAR
5	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI
4	27.09.13	REVISED AND ISSUED AS STD. SPEC.	RB	RKS	RBB	DM

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Abbreviations:

ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
IS	:	Indian Standard
LSTK	:	Lump Sum Trunkey
mm	:	Millimeter

Structural Standards Committee:

Convenor: Mr. Anurag Sinha

Members:
Mr. C. Damodaran
Mr. VK Panwar
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Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
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1.0 SCOPE

This specification covers the requirement of material and laying of Acid Resisting Brick/ tile lining for flooring on acid storage areas.

2.0 REFERENCES

2.1 Codes & Standards

IS 4457 Specification for ceramic unglazed vitreous acid resisting tile.
IS 4832 (Part-I) Chemical resistant mortar silicate type
IS 4832 (Part-II) Chemical resistant mortar Resin type
IS 4860 Acid resistant bricks
IS 9510 Specification for Bitumen Mastic, Acid resistant grade.

2.2 Specifications

ASTM D41-94 Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and waterproofing

Note: - Latest Edition of IS / codes and standards shall be followed

3.0 MATERIAL

3.1 Acid Resisting Bricks / Tiles

The Bricks shall conform to IS: 4860 – Class I quality. All bricks shall be dense, homogeneous and manufactured out of special raw material which shall have low lime, flint, sand and iron contents. These shall be specially fired and vitrified at high temperature to have qualities of low absorption. The size of the bricks shall normally be 230mm x 114mm x 64 mm or as per IS 4860. Ceramic unglazed Acid resisting tiles shall confirm to IS 4457. The size of Acid resisting tile shall be as per IS: 4457 or as defined in SOR.

3.2 Chemical Resistant Mortar

3.2.1 Silicate Mortar

It shall consist of selected potassium silicate solution and inert filter powder. Both mixed well to enable to set at ambient temperature. The mortar shall conform to IS 4832 (Part – I). The mixing proportion and other instructions for use shall be as specified standard manufacturers. Silicate mortar from standard manufacturers only shall be used. Contractor shall obtain approval from Engineer – in – charge prior to order and supply of the material. This type of Mortar is resistant to most acids except hydro-fluoric acid and concentrated ortho-phosphoric acid; they are not resistant to alkalies of any concentration or to boiling water or stream.

3.2.2 Resin Mortar

The furane and phenolic mortar for jointing consist of inert powder synthetic resin syrup. No water shall be used during mixing. This mortar shall conform to IS 4832 (Part – II). The mixing proportion and other instructions shall be as specified by standard manufacturers. Resin mortar from standard manufacturers only shall be used. Contractor shall obtain approval from Engineer – in – charge prior to order and supply of the material. This type of Mortar has a good resistance to non-oxidising mineral acids, and poor resistance to oxidising mineral acids. They are fairly resistant to inorganic alkalies and water.

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3.3 Bitumen Primer

A bitumen primer is an asphalt based material thinned with petroleum solvent (conforming to ASTM D-41) should be applied over the surface. Primers from standard manufacturers only shall be used.

3.4 Bitumen Mastic

The bitumen mastic shall consist of a mixture of asphalt cement mineral filler, and mineral aggregate, which are acid alkali resistant. The composition, preparation and properties of the bitumen mastic shall be as per IS 9510 for resisting acid. The bitumen mastic shall be insoluble in Benzol and the matter soluble in diluted hydrochloric acid should not be more than five percent. "Prodorphalte" by Coromandal Prodorite or equivalent may be used.

4.0 LAYING

4.1 Surface Preparation

a) All damaged or questionable areas should be chipped out and replaced.
b) Adequate floor slope for good drainage is important.
c) Low spot should be avoided because finished floor will follow contour or sub floor.
d) Concrete should be dry, clean and well cured before application of membrane is started.

4.2 Primer Application

A bitumen primer should be applied over the prepared surface. It should be allowed to dry before applying the membrane material.

4.3 Membrane Application

Bitumen mastic is used to build up the membrane. It is heated to 120-205° C and applied to the primed surfaces. Multiple coat application should be made to thickness requirements. The thickness of the mastic layer shall be to suit the acid concentration and expected load or as specified by the Engineer-in-charge. Each coat should be inspected for blisters and pinholes. If present, they should be broken and before applying subsequent coats. Bitumen mastic should not be used as the membrane material where solvents are involved.

4.4 Reinforcement Application

Bitumen coated glass cloth can be used for membrane reinforcements at the corners, edges, walls, etc. depending on the requirements.

4.5 Application of Mortar and Bricks/Tile

There are two ways of lining Acid resisting linings:

4.5.1 When Bedding and Jointing Material are the same

A thin layer of about 3mm suitable resinous mortar is spread on the back of the acid resisting tiles and the tiles are pressed down on the bed. Suitable joint thickness of about 3mm should be maintained. Jointing is done with suitable resin mortar.

4.5.2 When Bedding and jointing material are different

A thin layer of about 6mm suitable silicate type mortar is spread on the back of the acid resisting tiles and the tiles are pressed down on the bed. Proper joint thickness of about 3mm

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should be maintained and filled up with suitable resin type mortar. In case of pointing the joint thickness should be 6mm and depth of the pointing should be 19mm.

In this case, joints with silicate mortar should be acid cured with 20 to 25 percent hydrochloric acid or with 30 to 40 percent sulphuric acid before applying the resin type mortar. After acid curing, the free acid in the joints shall be cleaned with water and sufficient time should be allowed should be allowed for thorough drying. After curing resin mortar is used for filling up the joints.

5.0 GUARANTEE

The Vendor shall give material and performance guarantee for a period of minimum one year from the date of commissioning of the plant.

6.0 PAYMENT

6.1 Payment shall be on square meter basis of area covered.

6.2 The payment clause 6.1 is not applicable for LSTK Jobs.

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सुरक्षा शॉवर एवं आई वॉश हेतु मानक विनिर्देश

STANDARD SPECIFICATION FOR SAFETY SHOWER AND EYE WASH

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved By	
5	17.08.21	REVISED AND ISSUED AS STANDARD SPECIFICATION	GAURAV SINGH	GYAS	Anurag Sinha	SM
4	11.01.19	REVISED AND ISSUED AS STANDARD SPECIFICATION	GAURAV SINGH	GYAS	RS	RKT
3	17.07.12	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	JAY KUMAR	RC	RBB	DM
2	11.09.06	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION.	DCB	UCJ	VDS	VC
1	02.06.97	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	AK	PCS	MMK	AS

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Abbreviations:

GI	:	Galvanized Iron
IS	:	Indian Standard
Kg	:	Kilogram
LPM	:	Litre per minute
mm	:	Millimeter

Structural Standards Committee

Convener: Mr. Anurag Sinha

Members:
Mr. C. Damodaran
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar(Construction)

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1.0 SCOPE

This specification covers the general requirements regarding material, design, fabrication and acceptance tests for safety showers and Eye wash (combine unit).

2.0 CODES AND STANDARDS

IS: 1239	Mild steel tubes, tubular and other wrought steel fittings
IS: 10592	Specification for Industrial Emergency Shower, eye and face fountain and combination units.
Installation drawing	As per Vendor

3.0 DESIGN REQUIREMENT

3.1 It shall be as per IS : 10592.

3.2 The twin fountain head of eye wash unit shall give soft, controlled drenching of eye/face when the foot pedal is pressed.

3.3 Shower head should give uniform shower of water as soon as the chain/ pull rod is pulled.

3.4 Available inlet pressure shall not be less than 2.0 kg/cm^{2}g. In case available pressure is greater than 3.0 kg/cm^{2}g suitable Restriction Orifice shall be provided before safety shower and eye wash unit.

3.5 All steel parts shall be properly painted with 3 coats of anticorrosive paints.

3.6 Water supply pipe size shall be 40mm at inlet of combined equipment. Inlet connection shall generally be from top unless specified otherwise. Inlet connection shall be 1.5" flanged as per ASTM A105 (GALV.), 150FF.

3.7 Emergency shower head shall be capable of delivering a minimum of 76 lpm of water and each eye wash head shall be capable of delivering approximately 12 lpm.

4.0 MATERIAL OF CONSTRUCTION

Pipe	: GI heavy grade conforming to IS: 1239.
Pipe Fittings	: GI heavy grade conforming to IS: 1239 (II)/ CI conforming to IS:1879
Self closing Valve	: Gun Metal / Brass
Bowl for eyewash	: Stainless steel (SS 304)
Atomiser	: SS 304 with Copper head
Shower head	: C.P Brass or stainless steel(SS 304)
Foot Pedal	: M.S. with aluminium top
Spring	: M.S Galvanised
Pull chain	: M.S Galvanised

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5.0 INSPECTION AND TESTING

a) The whole assembly shall be tested for its hydraulic performance as per the requirements of IS 10592

b) EIL/Owner's representative shall have access at all reasonable times to the manufacturer's work in which safety shower/its components are being manufactured and/or tested.

6.0 MARKING

Combined unit shall be marked with ISI certification mark and other marking requirement as per IS 10592

7.0 VENDOR DATA REQUIREMENTS

7.1 Vendor shall furnish drawings and data as per VENDOR drawing and data requirements for approval prior to manufacturing.

7.2 Original transparencies after incorporating the as built information shall be got signed by the inspection engineer before submitting to EIL/OWNER for records.

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सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL AND STRUCTURAL WORKS

सामान्य परिधि
GENERAL SCOPE

Rev No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	28.02.2025	REVISED AND REISSUED AS SPECIFICATION	RGA	VIKRAM	AS	MN
5	04.07.2019	REAFFIRMED AND REISSUED AS SPECIFICATION	AVM	AJS	RS	RKT
4	28.03.2013	REAFFIRMED AND REISSUED AS SPECIFICATION	AJS	RS	PKM	DM
3	26.02.2008	REAFFIRMED AND REISSUED AS SPECIFICATION	PKB	PKM	VK	VC
2	08.06.2001	REAFFIRMED AND REISSUED AS SPECIFICATION	DPN	RPM	SCJ	MI
1	02.03.1994	ISSUED AS STD. SPECIFICATION		HM	GPL	AS

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Abbreviations:

IS : Indian Standards

Structural Standards Committee:

Convenor: Mr. Anurag Sinha

Members:
Mr. Virender Goel
Mr. Deepak Agrawal
Ms. Alpana Srivastava
Dr. Sudip Paul
Mr. Charanjit Singh (Projects)
Mr. Indrajit Neog (Construction)
Ms. Papia Mandal
Mr. Vikram Kumar Gupta

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1. These specifications establish and define the material and constructional requirements for CIVIL and STRUCTURAL WORKS.

2. Methods of measurements are indicated in these specifications; however, if not specified, latest revision of IS 1200 shall be applicable.

3. Providing and operating all necessary measuring and testing devices/ equipments including all materials and consumables are included in the scope of work. No separate measurement or payment for testing the quality of work and materials shall be made; rates quoted for various items shall be deemed to include the cost of such tests which are required to ensure achievement of specified quality.

4. All materials shall be of standard quality, manufactured by renowned concerns conforming to Indian Standards or equivalent, and shall have IS mark as far as possible unless otherwise approved by the Engineer-in-Charge. Wherever Vendor List is attached in the Tender document, the same shall be followed. The Contractor shall get all materials approved by the Engineer-in-Charge prior to procurement and use. The Contractor shall furnish manufacturer's certificates for the materials supplied by him when asked for. Further to that he shall get the materials tested from an approved test house if asked for by the Engineer-in- Charge. The cost for all the tests and test certificates for the material procured by the Contractor shall be borne by the Contractor. No separate payment shall be made for the testing. The Engineer-in-Charge shall have the right to determine whether all or any of the materials are suitable. Any materials procured or brought to site and not conforming to specifications and satisfaction of the Engineer-in-Charge shall be rejected and the Contractor shall have to remove the same immediately from site at his own expense and without any claim for compensation due to such rejection.

5. Wherever referred to in the tender document, only the latest version of BIS Specifications, Codes of Practice, etc. shall be applicable.

6. Wherever the Contractor executes civil and structural works involving buildings, equipment foundations, supporting structures, pipe racks, etc., the following works are deemed to have been included in the quoted rates for various works.

   - Marking of centre lines of foundations etc.
   - Establishing layout and levels of foundations and superstructure etc., including establishment of reference lines, bench marks on various floors, platforms etc.
   - General upkeep of the construction site, till completion of works and handing over.
   - Preparation of BBS.
   - Preparation of Fabrication drawings and getting approval from Engineer-in-Charge after incorporating all the comments.
   - Preparation of "As-Built" scheme of civil-structural drawings indicating constructed details including levels, centre lines, layouts, member sizes, MTO etc. complete.

7. The provisions of Schedule of Rates, specifications and drawings shall be read in conjunction with each other and in case of conflict amongst them, clarification shall be obtained from the Engineer-in-Charge whose decision shall be final and binding. However, the following procedure may generally be followed:

   - Description of items in schedule of rates shall be followed when provisions therein are different from those in specifications.

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- Where the description of item does not call for some specific requirement but the same is given in specifications, the specifications shall be followed in addition to the requirement given in description of item.

- Where drawings call for requirements different from or additional to those given in item description and specifications, the decision of the Engineer-in-Charge shall be obtained as to what shall be followed.

- All relevant General notes and Safety notes shall be followed

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सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

सामग्री
MATERIALS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	13.03.25	UPDATED & REISSUED	MI	AJS	ANURAG SINHA	M. NANDI
6	25.02.21	UPDATED & REISSUED	TK	AJS	AS	S.MAZUMDAR
5	16.05.16	UPDATED & REISSUED	MK	AJS	RS	R.NANDA
4	21.08.14	UPDATED & REISSUED	ASR	AS	PKM	S.CHANDA
3	19.06.09	REAFFIRMED & REISSUED	AS	SCH	VINAY KUMAR	N. DUARI
2	18.02.00	UPDATED & REISSUED	DPN	SKP	SC JAIN	A. SONI

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Abbreviations:

API	:	American Petroleum Institute
ASTM	:	American Society for Testing & Materials
BIS	:	Bureau of Indian Standards
BS	:	British Standard
C&D Waste	:	Construction and Demolition Waste
DIN	:	Deutsches Institut' für Normung
EC	:	Emulsifiable Concentrate
IS	:	Indian Standards
PCC	:	Plain Cement Concrete
PVC	:	Poly Vinyl Chloride
RA	:	Recycled Aggregates
RCA	:	Recycled Concrete Aggregates
RCC	:	Reinforced Cement Concrete

Structural Standards Committee

Convenor: **Mr. Anurag Sinha**

Members:
Mr. Virender Goel
Mr. Deepak Agrawal
Ms. Alpana Srivastava
Dr. Sudip Paul
Ms. Papia Mandal
Mr. Vikram Kumar Gupta
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1.0 SCOPE

1.1 This specification establishes and defines the requirements of various materials to be used in Civil and Structural 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 this specification, 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 this specification, the provision given in this specification shall be followed.

1.5 All 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 this specification 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 manufacturer's 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 test 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 All rejected materials shall be immediately removed from the site by the Contractor at his own cost.

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2.0 REFERENCES

As mentioned in the respective clauses.

3.0 WATER

3.1 Water used in construction for all civil & structural works shall be clean and free from injurious amount of oil, acids, alkalies, organic matters or other harmful substances which may be deleterious to concrete, masonry or steel. The pH value of water sample shall be not less than 6. Potable water shall be considered satisfactory. Underground water can also be used with the prior approval of Engineer-in-Charge, if it meets all the requirements of IS 456.

3.2 Tests on water samples shall be carried out in accordance with IS 3025 and they shall fulfill all the guidelines and requirements given in IS 456.

3.3 The Engineer-in-Charge may require the Contractor to prove, that the concrete prepared with water, proposed to be used, shall have average 28 days compressive strength not lower than 90% of the strength of concrete prepared with distilled water.

3.4 The Engineer-in-Charge may require the Contractor to get the water tested from an approved laboratory before starting the construction work and in case the water contains any oil/ organic matter or an excess of acid, alkalies or any injurious amount of salts etc., beyond the permissible maximum limits given in IS 456, the Engineer-in-Charge may refuse to permit its use. In case the water is supplied by the owner, contractor shall get himself satisfied regarding its quality before using the same in his works at his own expense. In case there is any change in source of water, water samples shall be tested again to meet the specified requirements.

3.5 Water shall be stored in tin barrels, steel tanks or water-tight reservoirs made with bricks / stone or reinforced concrete. Brick/ stone masonry reservoirs shall have RCC base slab and shall be plastered inside, with 1 part of cement and 4 parts of sand and finished with neat cement punning. These reservoirs shall be of sufficient capacity to meet the water requirement, at any stage of construction.

3.6 Water for curing shall be of the same quality as used for concreting and masonry works. Sea water shall not be used for preparation of cement mortar, concrete as well as for curing of plain/reinforced concrete and masonry works. Sea water shall not be used for hydrotesting and checking the leakage of liquid retaining structures also.

4.0 AGGREGATE

4.1 General

4.1.1 Coarse and fine aggregates for Civil and Structural Works shall conform in all respects to IS 383 (Specification for coarse and fine aggregate for concrete). Aggregates shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or a combination thereof or manufactured aggregates produced from other than natural sources. These shall be chemically inert, hard, strong, dense durable, clear and free from veins, adherent coatings, injurious amount of disintegrated pieces, alkalies, free lime, vegetable matter and other deleterious substances such as iron pyrites, coal, lignite, mica, shale, sea shells etc. Naturally occurring aggregates shall be obtained from an approved source known to produce the same satisfactorily.

Manufactured aggregates shall consist of Iron and Steel slag aggregates, Copper slag aggregates or aggregates made from Construction & Demolition (C&D) waste such as Recycled Aggregates (RA) and Recycled Concrete Aggregates (RCA). RA shall comprise of waste from concrete, brick, tiles, stone, etc. and RCA shall be derived from concrete after requisite processing. Extent of utilization of manufactured aggregates in RCC and PCC works shall be as per Table-1 of IS 383.

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4.1.2 Source and type of aggregates shall be got approved by the Engineer-in-Charge prior to procurement. Change in source and type of aggregates, at later stage, shall not be generally permitted; but under specific circumstances, Engineer-in-Charge can allow a change in source and type of aggregate. Contractor shall produce necessary test certificates from approved laboratories regarding the quality and suitability of the proposed aggregates and submit fresh mix design for approval of the Engineer-in-Charge. Any such change, if permitted by the Engineer-in-Charge, shall be without any time and cost implication to the owner.

4.1.3 Aggregates which may chemically react with alkalies of cement or might cause corrosion of the reinforcement, shall not be used. If so desired by the Engineer-in-Charge, the Contractor shall carry out alkali reactivity tests and submit the results to him for approval.

4.1.4 The maximum quantities of deleterious materials in the aggregates as determined in accordance with IS 2386 - Part II (Methods of Test for aggregates for concrete), shall not exceed the limits defined in IS 383. No special test is required to prove the absence of such deleterious matters if the aggregates are from a known source with satisfactory prior data on the properties of concrete made with them. In case of newly developed quarry sites, the contractor shall submit necessary test results as per IS 383 and IS 2386 to the Engineer-in-Charge prior to his acceptance and approval. The method of Sampling shall be in accordance with the requirements given in IS 2430.

4.1.5 Coarse and fine aggregates shall be batched separately. All-in-aggregate shall be used only where specifically permitted by the Engineer-in-Charge.

Separate sieve analysis and grading curves shall be prepared by the Contractor for any/ all batches of coarse and fine aggregates, and submitted to the Engineer-in- Charge, whenever asked for, to ensure conformity with those submitted along with the mix design.

4.1.6 Whenever required by Engineer-in-Charge, the aggregates (coarse/ fine) shall be washed and/ or sieved by the contractor before use in the works to obtain clean and graded aggregate at no extra cost to the owner.

4.1.7 Aggregates not in conformity with the specifications shall be rejected and the Contractor shall immediately remove them from the site of work.

4.2 Coarse Aggregates

4.2.1 Coarse aggregates are the aggregates, which are retained on 4.75 mm BIS Sieve. It shall have a specific gravity not less than 2.6 (saturated surface dry basis).

The grading of the aggregates shall be as per IS 383 or as required by the mix design, to obtain densest possible concrete. For this purpose, the contractor shall submit to the Engineer-in-Charge at least three sets of mix design and test results, each with different gradings of coarse aggregates, proposed to be used. The Engineer-in-Charge may allow "All-in-aggregates" to be used provided they satisfy the requirements of IS 383.

4.2.2 Coarse aggregates may be obtained from

a) Uncrushed gravel or stone which results from natural disintegration of rock

b) Crushed gravel or stone which results from crushing of gravel or hard stone

c) Partially crushed gravel or stone which results from blending of (a) and (b) above

d) Manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. Manufactured coarse

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aggregate may be RCA or RA processed from C&D waste and may be supplied as single sized or graded.

4.3 Fine Aggregates

4.3.1 Fine aggregates are the aggregates which pass through 4.75 mm BIS sieve but not more than ten percent (10%) pass through 150 micron BIS sieve. These shall comply with the requirements of grading zones I, II and III of IS 383. Fine aggregates conforming to grade zone IV shall not be used for reinforced concrete works.

Sand from sea shores, creeks or river banks affected by tides, shall not be used for filling or concrete works.

4.3.2 Fine aggregates shall consist of

a) Natural Sand : Fine aggregate resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies. This may also be called as uncrushed sand.

b) Crushed Sand –
   i) Crushed Stone Sand : Fine aggregate produced by crushing hard stone
   ii) Crushed Gravel Sand : Fine aggregate produced by crushing natural gravel

c) Mixed Sand : Fine aggregate produced by blending natural sand and crushed stone sand or crushed gravel sand in suitable proportions.

d) Manufactured Fine Aggregate : Fine aggregate manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. Manufactured fine aggregate may be RCA processed from C&D waste.

4.4 Sampling and Testing

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

4.5 Storage of Aggregates

4.5.1 Storage of all types of aggregates at site of work shall be at contractor's expense and risk and shall be stored as specified in IS 4082. Aggregates shall in no case be stored near to the excavated earth or directly over ground surface.

4.5.2 The Contractor shall maintain sufficient quantities of aggregates, near to the place of work, required for the continuity of the work. Each type and grade of aggregate shall be stored separately on hard, firm surface having adequate slope for drainage of water.

4.5.3 Aggregates delivered at site in wet condition or becoming wet due to rain or any other means, shall not be used for atleast 24 hours. The Contractor shall obtain prior approval of the Engineer-in-charge for the use of such aggregates and shall adjust the water content in accordance with IS 2386 to achieve the desired mix. In the absence of test results, and to allow variation in mass of aggregates and water content on account of moisture content, the

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Contractor can make suitable adjustment in the masses as per IS 456, for preparation of nominal mix concrete only.

5.0 SAND

5.1 Sand for Masonry Mortars

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

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

5.1.3 Unless found satisfactory as a result of further tests as may be specified by the Engineer-in-Charge, or unless evidence of such performance is offered which is satisfactory to him, the maximum quantities of clay, fine silt, fine dust and organic impurities in the sand, when tested in accordance with IS 2386, shall not be more than 5% by mass in natural sand, or crushed gravel sand or crushed stone sand. For organic impurities, when determined in accordance with IS 2386, colour of the liquid shall be lighter than that indicated by the standard solution specified in IS 2386.

5.1.4 **Grading of Sand**

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

GRADING OF SAND FOR USE IN MASONRY MORTARS

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

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

5.1.5 **Sampling and Testing**

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

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

5.2 Sand for Filling

Sand for filling shall meet the requirements of IS 383 and shall be natural sand, hard, strong, free from any organic and deleterious materials. Any sand proposed for filling, shall be used only after it is approved by the Engineer-in-Charge. Sand obtained from sea shores, creeks or river banks affected by tides, shall not be used for filling. Fine aggregates suitable for concreting works shall be suitable for filling also. No sand below grading zone-III as per IS 383 shall be allowed for filling.

6.0 CEMENT

Cement to be used for civil and structural works shall be one of the following. Specific requirement for the type of cement to be used shall be as shown in the drawings or as specified in the contract or as directed by the Engineer-in-Charge.

- Specification for 33/43/53 grade ordinary portland cement — IS 269
- Specification for portland slag cement — IS 455
- Specification for Portland pozzolana cement (fly ash based) — IS 1489 Pt.1
- Specification for Portland pozzolana cement (calcined clay based) — IS 1489 Pt.2
- Specification for Masonry Cement — IS 3466
- Specification for high alumina cement for structural use — IS 6452
- Specification for rapid hardening portland cement — IS 8041
- Specification for Sulphate Resisting Portland cement — IS 12330

6.1 Storage at Site

6.1.1 The storage of cement (lifted from the Owner's godown or procured by the Contractor himself) at the site of work shall be at contractor's expense and risk and shall meet the requirements of IS 4082. The cement shall be stored above ground in a suitable weather tight building or godown and in such a manner as to permit easy access for proper inspection and also to prevent deterioration due to moisture. In the event of any damage occurring to the quality of cement due to faulty storage or on account of negligence on the part of the contractor, such damages shall be borne by the contractor himself.

6.1.2 All approved cement shall be arranged in batches with type, brand and date of receipt flagged on them. A maximum of eight bags shall be stacked one over the other. Cement bags shall be used in the same order as received from the manufacturer/ owner. The contractor shall maintain a register, on day-to-day basis, giving the details of the receipt/ consumption, source of supply and type of cement etc. The register shall always be accessible to the Engineer-in-Charge for verification.

6.2 Tests after Delivery

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

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analyses required to ensure quality of cement before using in actual works, irrespective of the fact whether the cement is supplied by the Owner or procured by him.

6.3 Rejection

The Engineer-in-Charge may reject at his discretion any cement, notwithstanding the manufacturer's certificate or failing to meet the requirements of relevant BIS Codes for testing of cement. He may similarly reject any cement which has deteriorated owing to inadequate protection from moisture or due to intrusion of foreign matter or any other cause. Any cement which is considered defective, shall not be used and shall be promptly removed from the site by the contractor.

7.0 STEEL

7.1 General

All steel bars, sections, plates, and other miscellaneous steel materials, etc shall be free from loose mill scales, rust as well as oil, mud, paint or other coatings. The materials, construction specifications such as dimensions, shape, weight, tolerances, testing etc, for all materials covered under this section, shall conform to respective BIS Codes. Steel sections shall be conforming to IS 808 or IS 12778.

7.2 Reinforcement Bars

Reinforcement bars, to be used for civil and structural works shall be one of the following or in combination thereof.

- Mild Steel and Medium Tensile Steel Bars and Hard-Drawn Steel Wire for Concrete Reinforcement — IS 432
- Specification for hard drawn steel wire fabric for concrete reinforcement — IS 1566
- Specification for plain hard-drawn steel wire for prestressed concrete. — IS 1785
- Specification for High strength deformed steel bars and wires for concrete reinforcement. — IS 1786
- Specification for indented wire for prestressed concrete. — IS 6003
- Specification for fusion bonded epoxy coated reinforcing bars — IS 13620

7.3 Structural Steel

Structural steel to be used for general structural purposes shall be one of the following or in combination thereof.

Structural steel sections shall conform to following BIS Codes:

- Steel tubes for structural purposes. — IS 1161
- Mild Steel Tubes, tubulars and other wrought steel fittings. — IS 1239
- Steel for general structural purposes (Grade A/BR/B0). — IS 2062
- Hollow steel sections for structural use. — IS 4923

7.4 Miscellaneous Steel Materials

Miscellaneous steel materials shall be conforming to the following BIS Codes.

- Expanded Metal Steel Sheets for General purposes. — IS 412
- Mild steel bars of anchor bolts, rungs, metal inserts, grating etc.) — IS 2062
- Hexagonal head bolts, screws & nuts of product grade C. — IS 1363

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- Cold formed light gauge structural steel sections. IS 811
- Technical supply conditions for threaded steel fasteners. IS 1367
- Plain washers IS 2016
- Steel wire ropes for general engineering purposes IS 2266
- Thimbles for wire ropes. IS 2315
- Bulldog grips. IS 2361
- Mild Steel Tubes, tubulars and other wrought steel fillings. (For Hand rail tubular sections). IS 1239
- Drop forged sockets for wire ropes for general engineering purposes. IS 2485
- Steel chequered plates. IS 3502
- Hexagonal bolts and nuts (M42 to M150). IS 3138
- High Strength Structural Bolts IS 3757
- High Strength Bolts IS 4000

7.4.1 Anchor Bolts

Material for Anchor Bolts such as MS bars, washers, nuts, pipe sleeves and plates etc. shall be as per relevant BIS Codes mentioned above.

7.5 Storage

The storage of all materials at site of work shall be at the contractor's expense and risk and shall be done as per the requirements given in IS 4082. The contractor shall maintain the proper records of receipt/consumption. The records shall always be accessible to the Engineer-in-Charge for verification.

The reinforcement bars, structural steel sections and other miscellaneous steel materials etc, shall be stored in such a way as to avoid and prevent deterioration, corrosion, bending, twisting and wrapping. In case of any damage occurring to the material on account of faulty storage or negligence by the contractor, same shall be borne by the contractor himself.

7.6 Tests after Delivery

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

7.7 Rejection

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

8.0 BRICK

8.1 General

All Bricks used for masonry works shall conform to the requirements of following BIS Codes:

- Common Burnt Clay Bricks- Specifications IS 1077

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- Pulverized Fuel Ash Cement Bricks- Specifications IS 16720
- Pulverized Fuel Lime Ash Bricks- Specifications IS 12894
- Burnt Clay Fly Ash Bricks- Specifications IS 13757

8.1.1 Common Burnt Clay Bricks

Bricks for masonry works shall conform to IS 1077 - Specification for common burnt clay building bricks and shall be of class 5.0 (with minimum compressive strength of 5.0 N/mm^2). Specific requirement for any other class of bricks shall be as shown in drawings or as described in the contract for a particular site or type of work. Physical requirements, quality, dimensions, tolerances etc. of common burnt clay building bricks shall conform to the requirements of IS 1077.

Bricks shall be hand - moulded or machine moulded and shall be made from suitable soils. The bricks shall have smooth rectangular faces with sharp corners and shall be well burnt, sound, hard, tough and uniform in colour. These shall be free from cracks, chips, flaws, stone or humps of any kind.

8.1.2 Pulverized Fuel Ash Cement Bricks

Pulverized fuel ash-cement bricks shall conform to IS 16720. The bricks shall be sound, free from visible cracks and uniform in shape and colour. The brick shall have total pulverized fuel ash content not less than 35 percent of the mass of bricks. Pulverized fuel ash shall conform to IS 3812 (Part 1) or IS 3812 (Part 2).

8.1.3 Fly Ash Lime Bricks (FALG Bricks)

The Fly Ash Lime Bricks (FALG Bricks) shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. Fly ash shall conform to IS 3812.

8.1.4 Burnt Clay Fly Ash Bricks

The burnt clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly Ash shall conform to grade I or grade II of IS 3812.

8.1.5 Mechanized Autoclave Fly Ash Lime Brick

These bricks shall be machine moulded and prepared in plant by appropriate proportion of fly ash and lime. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and of 100/80 mm in length, 40 mm width and 10 to 20 mm deep one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

8.2 Tests after Delivery

The Contractor shall take samples of each type of brick as directed by the Engineer-in-Charge as per the requirements of IS 5454 and tests shall be carried out as per IS 3495. The cost for carrying out any or all the tests, shall be borne by the Contractor. The bricks, when tested, as

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per IS 3495 shall have a minimum average compressive strength, as given in the Code, for a particular class of brick. Water absorption shall not be more than 20% by its dry weight, when soaked in cold water for 24 hours.

Brick samples so approved, shall be deposited with the Engineer-in-Charge. All subsequent deliveries shall be upto the standards of the approved samples.

8.3 Stacking of Bricks

Bricks shall be stored at site as per the requirements given in IS 4082 and shall not be dumped at site. They shall be unloaded from trucks to a place on a levelled surface near to the work site. They shall be stacked in regular tiers even as they are unloaded, to minimise breakages and defacement of bricks. The supply of bricks shall be so arranged that as far as possible, at least two days' requirements of bricks are available at site at any time. Bricks, of different class & types, shall be stacked separately.

8.4 Local Bricks/ Class 3.5 Bricks.

Where shown on drawings, locally available bricks of non modular size (230 mm x 110 mm x 70 mm) in place of bricks of modular size (190 mm x 90 mm x 90 mm) can be used in case the bricks satisfy the other requirements of respective BIS codes. Minimum compressive strength of these bricks shall not be less than 3.5 N/mm^2.

8.5 Concrete Block Masonry

Concrete Block Masonry shall be as per EIL Specification No. 6-68-0016.

9.0 STONE

9.1 General

All Stones used for masonry works shall conform to the requirements of following BIS Codes.

- Method of identification of natural building stones. IS 1123
- Recommendations for dimensions and workmanship of natural building stones for masonry work. IS 1127
- Recommendations for dressing of natural building stones. IS 1129

9.2 Quality of Stones

Stones shall be of approved quality, hard, dense, strong, sound, durable, clean and uniform in colour. They shall also be free from veins, adherent coatings, injurious amount of alkalies, vegetable matters and other deleterious substances such as iron pyrites, coal, lignite, mica, sea shells etc. Unless otherwise approved, stones from one single quarry shall be used for any one work. The strength of stones should be adequate to carry the imposed load and shall meet all the requirements of IS 1905, taking into account the appropriate crushing strength of stone and type of the mortar used. The percentage of water absorption, when tested in accordance with IS 1124, shall not exceed 5 percent.

Stones normally used, shall be small enough to be lifted and placed by hand. The length of the stone shall not exceed 3 times the height. Width of stone on base shall not be less than 150 mm and in no case exceed $3/4^{th}$ thickness of the wall. Height of the stone shall not be more than 300 mm.

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9.3 Unloading/Stacking

The stones shall be unloaded from the trucks to a site near to the place of work as defined in IS 4082 and shall be stacked on a firm ground having adequate stope for drainage. The supply of stones shall be so arranged that as far as possible, at least two days' requirements of stone are available at site at any time.

10.0 ADMIXTURES

10.1 General Requirements for Admixtures

10.1.1 All concrete admixtures shall in general comply with the following BIS Codes unless otherwise stipulated in this specification.

- Specification for integral cement water proofing compounds. IS 2645
- Specification for other admixtures for concrete. IS 9103

10.1.2 Generally, admixtures shall have ISI certification marks. However, even in case of BIS certified admixtures, Engineer-in-Charge may require the Contractor to carry out and submit any or all the tests (as specified in relevant BIS Codes), from BIS approved laboratories, over and above the manufacturer's test certificate, before giving his final approval.

In case, admixtures certified by BIS are not available, the contractor shall submit to the Engineer-in-Charge the type and/or proprietary brand of the admixture from only reputed manufacturers along with necessary test certificates from BIS recognized/ BIS approved laboratories or any other document directed by Engineer-in-Charge for the latter's final approval. In such cases, names of at least two manufacturers shall be submitted to the Engineer-in-Charge for his selection. In case, both the names are rejected, the contractor shall submit a fresh list of two manufacturers for approval by the Engineer-in-Charge.

The Engineer-in-Charge may direct the contractor to submit test results as required by IS 2645 or IS 9103 for any admixture proposed to be used in the concrete in any approved laboratory at his discretion at any stage of the work. The cost of any/all tests required to satisfy compliance with this specification shall be borne by the Contractor.

In case of non-availability of any BIS code for testing and acceptability criteria, relevant American, British or German Code shall be applicable.

10.1.3 Prior approval of the Engineer-in-Charge shall be obtained while using water reducing admixtures in the concrete (PCC/ RCC) or mortar. Other type of admixtures such as accelerating admixtures, retarding admixtures or air entraining admixtures, shall not be used unless specified on the design drawings or prior approval taken from the design approving authority. Once approved, utmost care shall be exercised at site by the Contractor to maintain the consistency in the quality of admixture and the concrete/ mortar so produced.

10.1.4 The suitability and effectiveness of any admixture shall be verified by trial with the designed concrete mixes using cement, aggregates together with any other materials to be actually used in the works as per the direction of Engineer-in-Charge. If two or more admixtures are to be used simultaneously in the same concrete mix, the Contractor must submit necessary test results from an approved laboratory to show their interaction and compatibility. Any/all tests specified in BIS Codes shall be carried out only with the type of material and mix design, to be actually used in the work site.

10.1.5 No admixture shall impair the durability of the concrete nor combine with the ingredients to form harmful compounds nor increase the risk of corrosion of reinforcement. Use of admixtures shall not reduce the dry density of concrete. Once the proportion of admixture has

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been established, strict check shall be maintained not to alter the proportions of ingredients and water-cement ratio of the Design Mix during execution.

10.1.6 The chloride contents in admixtures shall not exceed 2% by mass of the admixture or 0.03% by mass of the cement.

10.1.7 Admixtures which do not meet the requirements stipulated in this specification shall be rejected and shall not be used.

10.2 Water Proofing Compounds

10.2.1 Water proofing compounds shall be mixed with cement only.

10.2.2 The permeability of the specimen with the admixture shall be less than half of the permeability with similar specimen without the use of these compounds. These compounds shall be used in such proportion as recommended by manufacturer but in no case it shall exceed 3% by weight of cement.

10.2.3 The initial setting time of the cement with the use of these compounds shall not be less than 30 minutes and final setting time shall not be more than 10 hours. Test shall be carried out in accordance with IS 4031.

10.2.4 Compressive strength of specimen at 3 days shall not be less than 160 kg/sq.cm nor 80% of the 3 days compressive strength of mortar cubes prepared with same cement and sand only, whichever is higher. Similarly compressive strength at 7 days shall not be less than 220 kg/sq.cm nor less than 80% of the 7 days compressive strength prepared with the same cement and sand only, whichever is higher. The test to determine the compressive strength shall conform to IS 4031.

10.3 Concrete Penetrating Corrosion Inhibiting Admixture shall be as per EIL Specification No. 6-68-0017.

11.0 WATER BARS (WATER STOPS)

11.1 PVC water bars shall be used in reinforced concrete construction of liquid retaining structures or any other structure to safeguard them from hydrostatic pressure and water leakage and any relative movement between two parts of the structure due to thermal loading shrinkage or differential movement of foundations. Wherever desired or shown in the drawings, they shall be used at expansion/contraction/construction joints. These shall be pre-formed and shall provide a permanent water tight seal along the entire joint in the poured concrete structures. These shall also be flexible enough to withstand deflection/displacements at joints arising due to variation of temperatures or settlement of foundations. The minimum thickness of water bar shall be as shown on drawings or described in the schedule of rates and unless otherwise mentioned, these shall be able to withstand a water head of at least 12 meters.

11.2 Performance requirements of PVC water bars shall meet the requirements of IS 12200. These shall be of approved make and of ribbed/ serrated/ plane type with a bulb at the centre. The thickness and width of water bars shall be as per schedule of rates/ drawings but in no case the thickness shall be less than 5 mm and width less than 150 mm. The joining of the water bars shall be carried out by vulcanising strictly as per the manufacturer's specifications. Lapped joints shall not be allowed under any circumstances.

12.0 BITUMEN/BITUMINOUS MATERIALS

Bitumen to be used for various types of work shall meet all the requirements of relevant BIS Codes as given below:

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- Specification of Paving Bitumen IS 73
- Specification for bitumen mastic for flooring IS 1195
- Specification for Bitumen felts for water proofing and damp proofing IS 1322
- Specification for Bituminous compounds for water proofing and caulking purposes IS 1834
- Specification for preformed fillers for expansion joint in concrete pavements and structures IS 1838
- Specification for bitumen mastic for use in water proofing of roofs IS 3037
- Specification for bitumen primer for use in water proofing and damp proofing IS 3384
- Specification for Bitumen Mastic for Tanking and Damp proofing IS 5871
- Specification for Glass fibre base coal tar pitch & bitumen felts IS 7193
- Code of practice for damp proofing using bitumen mastic IS 7198
- Specification for bitumen Mastic, Anti-Static and electrically conducting grade IS 8374

The type and grade shall be as shown on the drawings or as indicated in schedule of quantities or as directed by Engineer-in-Charge. Tests and acceptable criteria shall be as per relevant BIS Codes.

13.0 PVC PIPES

PVC Pipes shall conform to the requirements of IS 4985.

14.0 WOOD/ TIMBER

14.1 Wood recommended for platforms of cold vessels or below cold vessels/ exchangers shall be hard and shall be of group A, grade I, and shall have safe permissible stress of 7 N/mm^2 in compression, perpendicular to grains on outside location as per IS 883. General characteristics like durability, treatability etc. shall conform to IS 883 and IS 3629.

14.2 Timber required to be used for formwork shall be fairly dry before use. It should maintain its shape during the use and even when it comes into contact with moisture from the concrete. Storage of Wood/Timber shall be as per the requirements of IS 4082.

For proper identification and selection of suitable timber for formwork, following codes shall be referred.

- Classification of commercial timbers and their zonal distribution IS 399
- Specification for ballies for general purposes. IS 3337
- Specification for Ply wood for concrete shuttering work. IS 4990

15.0 EPOXY COMPOUNDS

Refer EIL Specification No. 6-68-0056.

16.0 PAINT

16.1 Refer EIL Specification No. 6-79-0020 or the job specification whichever applicable.

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17.0 ANTITERMITE COMPOUNDS

17.1 Following chemicals as per IS 6313 (Part 2 & 3) shall be used for treatment of soil for protection of buildings against attack by subterranean termites:

S.No.	Chemical	Relevant Standard	Dosage* (Chemical Emulsion)
1	Chlorpyrifos 20% Emulsifiable Concentrate (EC)	IS 8944	250ml in 5 litre water 50ml in 1 litre water
2	Imidacloprid 30.5% Suspension Concentrate (SC)	IS 16131	10.5ml in 5 litre water 2.1ml in 1 litre water
3	Bifenthrin 2.5% Emulsifiable Concentrate (EC)	IS 15936	100ml in 5 litre water 20ml in 1 litre water

(*Dosage as specified above or as per Manufacturer's recommendation, whichever is stringent)

18.0 POLYSULPHIDE SEALANTS

Polysulphide Sealants shall conform to IS 12118 and be of approved make. Test conditions and requirements shall be as given in the above referred BIS code.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

मिट्टी का कार्य

EARTHWORK

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	18.03.21	REVISED & REISSUED	TK	AJS	AS	SM
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3	22.01.02	UPDATED & REISSUED	R SOOD	R SOOD	H MATHUR	GRR
2	AUG'94	UPDATED & REISSUED	-	H MATHUR	GP LAHIRI	A. SONI

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Abbreviations:

CNS : Cohesive Non Swelling

Structural Standards Committee

Convenor : Mr. Anurag Sinha

Members:
Mr. C Damodaran
Mr. V.K.Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjit Singh (Projects)
Mr. Ravindra Kumar (Constn.)

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1.0 SCOPE

This specification deals with earth work in excavation and filling.

2.0 CLASSIFICATION OF SOIL

2.1 Ordinary Soil

2.1.1 Soft Soil/ Loose Soil

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

a) Sand, gravel, loam, clay, mud, black cotton soil
b) Vegetables or organic soil, turf, peats, soft shale or loose murrum
c) Mud concrete below ground level
d) Any mixture of soil mentioned above.

2.1.2 Hard/ Dense Soil

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

i) Stiff heavy clay, hard shale or compact murrum requiring grafting tool and/ or pick and shovel
ii) Shingle and river or nallah bed boulders
iii) Soling of roads, paths etc. and hard core
iv) Macadam surface of any description (water bound, grouted tarmac etc.)
v) Lime concrete, stone masonry in lime or cement mortar below ground level
vi) Soft conglomerate when the stone can be detached from the matrix with picks and shovels

2.2 Soft Rock

This is fissured/ disintegrated rocky strata, boulders (volume more than 0.028 m^3 and less than 0.400 m^3) 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, thinly bedded phillites, 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 and permitted, light blasting may be restored to, for loosening the materials, but this will not, in any way entitle the material to be classified as "Hard Rock".

2.3 Hard Rock

2.3.1 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 and shall not be resorted unless permitted by the Engineer-in charge.

2.3.2 Hard Rock (Requiring General Blasting)

This shall include all types of hard and compact rock occurring in unfissured masses or similar foundations, boulders (volume more than 0.4 m^3) for excavation in which blasting is

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considered necessary such as quartzite, granite, basalt stones, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

2.3.3 **Hard Rock (Requiring Controlled Blasting (Explosive/ Non-explosive)**

This type of excavation becomes necessary when excavation is done in formations, mentioned in Clause 2.3.2, in the vicinity of existing foundations/ structures. Mode of blasting shall be decided by Engineer-in-Charge, keeping in view the sensitivity of structures.

2.3.4 **Hard Rock (Blasting Prohibited)**

Hard rock requiring blasting as described in clause 2.3.2 above, but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging, pneumatic/ hydraulic/ electro-mechanical breaking by using splitter or by chemical means or any other agreed method.

The use of excavation shall not be considered as a reason for classification under hard rock requiring blasting unless clearly found necessary in the opinion of Engineer-in-Charge.

3.0 BACKFILLING MATERIAL

3.1 Suitable Materials:

3.1.1 Back filling suitable material shall be approved by the Engineer-in-charge. Additionally, they shall be free from refuse, large stones or rocks or other material which might prevent proper compaction or cause the compacted fill or embankment to perform inadequately or to have insufficient stability or bearing capacity for the superimposed loads to which it is likely to be subjected.

3.1.2 Back filling of excavation in trenches, foundations and elsewhere shall consist of one of the following materials as shown on drawing, or directed by the Engineer-in-charge.

i) Soil
ii) Selected earth from heaps or brought from borrow areas.

In case i) or ii) are not available, the Engineer-in-charge may approve use of any of the following:

iii) Stone/ Gravel
iv) Sand
v) CNS material.

3.1.3 The material shall be free from refuse, debris, roots, hard lumps and any other foreign organic material.

3.2 Unsuitable Materials

Unsuitable material shall include particles in excess of 75 mm size and that which is:

a) Organic material, logs, stumps and perishable materials.
b) Material susceptible to spontaneous combustion
c) Materials with undefined properties
d) Materials having a moisture content greater than the maximum specified
e) Building rubble and domestic and industrial wastes
f) Soils and rock susceptible to deterioration/ change of their properties.

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g) Clay, silt and other loose or soft soils not in accordance with compaction criteria.
h) Dredged material
i) Material containing gypsum or other soluble salts.

4.0 SETTING OUT

4.1 The Contractor shall be responsible for the true and proper setting out of the work in relation to original points, ***lines**** and ***levels**** of reference and for the correctness of the levels, dimensions and alignment of all parts of the work. If at any time during progress of the work any error appears or arises in the position of level, dimension, or alignment of part of the work, the Contractor at his own expense shall rectify such errors to the satisfaction of the Engineer-in-Charge. The checking of any line or level by the Engineer-in-Charge shall not in any way relieve the Contractor of his responsibilities.

4.1.1 Tolerances*

The grade shall be properly shaped to the required elevations and parallel to the required surface. The elevation of any point and the line of any edge or center of the earthworks shall conform to that shown on the drawings within the tolerances stated below:

	Tolerances from True Level	Tolerances from True Line
Basic Grading	- 25 mm	- 75 mm
Embankments	+75 mm - 0	+75 mm - 75 mm

4.2 The Contractor shall lay out and construct one or more permanent bench marks in some central place before the start of the work, from which all important levels for the excavations will be set.

These permanent bench marks shall consist of masonry pillars with top neatly plastered and leveled as per the directions of the Engineer-in-Charge. Bench marks shall be well connected with triangular grid system or any other bench mark approved by the Engineer-in-Charge.

5.0 EARTHWORK IN EXCAVATION

5.1 Excavation shall be carried out in any material met on the site to the lines, levels and contours shown on the detailed drawings and the Contractor shall remove all excavated materials to spoil heaps on site or transport for use in filling on the site or stack them for reuse as directed.

5.2 Excavated material shall not be deposited within 1.5 m from the top edge of the excavation.

5.3 The sides of the excavation may be cut sloping, or shored and strutted to hold the face of earth as per site requirements and as directed by the Engineer-in- Charge.

5.4 Foundation pits/ trenches shall not be excavated to the full depth unless construction is imminent. The last 15 cm depth of the excavation shall not be done until concreting work is imminent. The full depth may at the discretion of the Engineer-in-Charge be excavated and the bed covered with a 50 mm (minimum) thick (or as indicated on drawing) layer of lean concrete 1:5:10 mix (1 cement : 5 coarse sand : 10 crushed stone aggregate) or as specified in schedule of rates/ shown on drawing, after watering if required, and consolidating the bed.

5.5 If the bottom of any excavation has been left exposed by the Contractor and in the opinion of the Engineer-in-Charge, that has become badly affected by the atmosphere or by water, then the Contractor shall remove such portions of the deteriorated material as the Engineer-

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in-Charge may direct and shall make good with lean concrete 1:5:10 mix (1 cement : 5 coarse sand : 10 crushed stone aggregate). All expenses for such additional concrete and excavation shall be borne by the Contractor.

5.6 Where excavation is made in excess of the depth required, the Contractor shall, at his own expense, fill upto required level with lean concrete 1:5:10 mix (1 cement : 5 coarse Sand : 10 crushed stone aggregates) or as decided by Engineer-in-Charge.

5.7 The Contractor shall provide suitable drainage arrangement to prevent surface water from any source entering the foundation pits at his own cost.

5.8 The Contractor shall make all arrangements for dewatering during excavation and subsequent works, the accumulated water from any source (including subsoil water) in the excavated pits/trenches and keeping the excavated pits/ trenches dry for subsequent works.

5.9 The Contractor shall make necessary arrangements for lighting, fencing and other suitable measures for protection against risk of accidents due to open excavation.

5.10 Where the excavation is to be carried out below the foundation level of an adjacent structure, the precaution to be taken such as under pinning, shoring and strutting etc. shall be determined by the Engineer- in-Charge. No excavation shall be done unless such precautionary measures are carried out as per directions of the Engineer-in-Charge. The payment for such precautionary measures shall, however, be made separately.

5.11 Loose or soft bed ground encountered in excavation at the required depth shall on the Engineers-in-Charge's instructions be excavated to a firm bed and difference made up to the required level with lean concrete 1:5:10 mix (1 cement : 5 coarse Sand : 10 crushed stone aggregates).

5.12 In those cases where during excavation, side slips occur for reasons not attributable to the Contractor (e.g. side slips which take place on their own but not due to surcharge of earth kept near the edge of excavation and cracking of excavation top strata due to clay drying out leading to collapse of excavation sides), the Engineer-in-Charge shall admit payment at his discretion.

5.13 Any obstacle encountered during excavation shall be reported immediately to the Engineer-in-Charge and shall be dealt with as instructed by him. Removal of buried pipes or cables shall not be done without prior permission of the Engineer-in-Charge and the Contractor shall provide all measures to protect the same. Cost of such protective measures are deemed to be included in the rates for various items of excavation.

5.14 The Contractor shall not undertake any concreting in foundation until the excavation pit/trench is approved by the Engineer-in-Charge.

5.15 The specification for earth work shall also apply to excavation in rock in general.

5.16 In case of hard rock requiring blasting, the provisions mentioned below shall be strictly followed.

5.16.1 **General**

Where hard rock is met with and blasting operations are considered necessary, the Contractor shall intimate about the same to the Engineer-in-Charge, and obtain his approval in writing for resorting to blasting operation.

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The Contractor shall obtain license from the district authorities for undertaking blasting work as well as for obtaining and storing the explosive as per the Explosive Rules 2008, corrected upto date. He shall purchase the explosives, fuses, detonators etc. only from a licensed dealer. He shall be responsible for the safe custody and proper accounting of the explosive materials. The Engineer-in-Charge or his authorised representative shall have the access to check the Contractor's store of explosive and his accounts.

In case where explosives are required to be transported and stored at site, relevant clauses of the Explosive Rules, 2008 as amended subsequently, shall apply.

The Contractor shall be responsible for any accident to workmen, public or property, due to blasting operations.

5.16.2 **Precautions**

Blasting operations shall be carried out under the careful supervision of a responsible authorised and licensed blaster of the Contractor (referred subsequently as "blaster" only) during specified hours, as approved in writing by the Engineer-in-Charge. The blaster shall be fully conversant with the rules of blasting.

Proper precautions for safety of persons shall be taken. Red flags shall be prominently displayed around the area to be blasted and all the people on the work except those who actually light the fuses, shall withdraw to a safe distance of not less than 200 m from the blast. Precautions as per Explosive Rules 2008 with amendment shall be followed.

5.16.3 **Fuses**

All fuses shall be cut to the lengths required before being inserted into the holes. Joints in fuses shall be avoided. Where these are unavoidable, a semicircular niche shall be cut in one piece of fuse about 2 cm. deep from the end and the end of other piece inserted into this niche, and the two pieces then wrapped together with a string. All joints exposed to dampness shall be wrapped with rubber tape. Fuse and detonators shall be kept separated from the explosives.

5.16.4 **Blasting with Gun Powder**

Blasting shall normally be done with gun powder. Dynamite, gelatine or any other high explosive shall only be used in special cases with the written permission of the Engineer-in-Charge.

In case of blasting with gun powder, the position of all bore holes to be drilled shall be marked out in circles with white paint. The bore holes shall be jumped or drilled in the rock face. The depth of bore hole shall be about the same as that of the line of least resistance and its size shall be such that the cartridges can easily pass down to the bottom. The bore holes must be dried before being charged and these shall be inspected by the Contractor's agent.

Gun powder may be used in the form of pellet blasting cartridges or as powder or granules. Cartridges are provided with tapered central hole. One end of fuse is passed through the narrow end of the hole and a sufficient length of the fuse is doubled back so that when the fuse is pulled, it is held tight in the tapered hole of the cartridge. Other cartridges are then inserted in the fuse to make up the required charge. The cartridge along with the fuse is lowered down in the bore hole, placed in position and gently filled and pressed home with dry hay or turf. The rest of the bore shall then be filled with dry clay, which shall be tamped with copper or brass rod until it becomes compact. Care shall be taken to avoid any possibility of an air space around the fuse. The safety fuses shall be taken to the required distance so as to allow the blasting to take place after the person lighting the fuse has withdrawn to a safe distance.

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Where gun powder is used in the form of powder or granules it shall be introduced in the bore hole by means of funnel or copper tube. The bore holes shall be loaded with two thirds of the quantity of charge required, and safety fuse then directly introduced over the charge. Remaining one third charge shall then be introduced, and gently filled and pressed home with dry hay or turf. The rest of the bore hole shall be filled with dry clay in the same way as for cartridges, and the safety fuse taken to the required distance.

The charges shall be fired by igniting the fuse. The number of charges to be fired and the actual number of shots heard, shall be compared, and the Contractor's blaster shall satisfy himself by examination that all the charges have exploded, before workmen are permitted to approach the site. The charge which has not exploded, shall not be permitted to be withdrawn. The tamping and charge shall be flooded with water and the holes marked with a red cross (X) over it. Another hole shall be jumped at a distance of about 45 cm from the old hole and fired in the usual way. This operation shall be continued, till the original and any subsequent unfired charges are exploded.

5.16.5 **Blasting with Dynamite or any other High Explosive**

In case of blasting with dynamite or any other high explosive the position of all bore holes to be drilled shall be marked out in circle with white paint. These shall be inspected by the Contractor's blaster. Bore holes shall be of a size that the cartridge can easily pass down. After the drilling operation, the blaster shall re-inspect the holes to see that the holes marked out by him have been drilled. The Blaster shall then prepare all charges necessary for the bore holes. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Wooden tamping rods (not pointed but cylindrical throughout) shall be used, in charging holes. Metal rods shall never be used for tamping. One cartridge shall be first placed in the bore hole, gently pressed and not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuse of required length.

The maximum of eight (8) bore holes shall be loaded and fired on each occasion. The charges shall be fired successively and not simultaneously.

Immediately before firing a blast, due warning shall be given and the blaster shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the blaster, who shall see that all the fuses are properly ignited.

Careful count shall be kept by him and others of each blast as it explodes. After the blast the blaster shall inspect the work and ascertain that all the charged holes have been exploded. In case of misfired holes, the Blaster shall inspect the same after half an hour and mark red crosses (X) over the holes. During this interval of half an hour, no body shall approach the misfired holes. None of the drillers shall work near such holes, until one of the two following operations has been done by the blaster.

a) Either the Contractor's blaster shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator, after which a fresh detonator, primer and fuse shall be placed in the misfired holes and fired.

OR

b) The hole shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm away and parallel to it. This hole shall be charged and fired. The misfired hole should also explode along with the new one.

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Before leaving the work, the blaster of one shift shall inform another blaster relieving him for the next shift, of any cases of misfire, and shall point out their positions denoted by red crosses and also state the action, if any, to be taken in the matter.

The Engineer-in-Charge shall also be informed by the blaster of all cases of misfire, their causes and steps taken in that connection.

5.16.6 **Controlled Blasting (Explosive/ Non-explosive)**

Whenever required by the Engineer-in-Charge, rock blasting shall be carefully controlled so that vibrations generated during the blasting do not cause damage to the buildings and installation around. Similarly, the rock pieces should not fly off and endanger the buildings and installations around. Apart from the general precautions mentioned in the preceding paragraphs, following protective measures and limits for use of explosive are suggested as guidelines. Bidders are requested to carefully check the site conditions and submit details of the scheme they propose to adopt for controlling the blast.

Following protective measures shall be adopted while carrying out blasting operations.

The hole shall be covered with mild steel plate of minimum 12 mm thickness.

Reinforcement rod mesh not less than 20 mm dia. at 150 mm centre in both directions shall be placed over the steel plates.

Steel plate and reinforcement shall be inspected after every blasting operation and all twists shall be removed before reuse to the satisfaction of the Engineer-in-Charge.

Sand filled bags of 6 to 8 layers shall be placed over the mesh suitably covering the whole region under blasting operation.

The thickness of covering plate and the kind of dead weight is to be duly approved by the Engineer-in-Charge.

5.16.7 Hard rock requiring blasting as described under Clause 2.3.2 above, but where blasting is prohibited for any reason(s), breaking up of rock can be done by using Splitter and/or chemical substances of approved manufacturer mixed in an appropriate proportion. The method involves drilling holes into rock and then inserting Splitter (hydraulic/ pneumatic/ electro-mechanical) or injecting Chemical solvents into the holes. The breaking-up of rock takes place in a controlled fashion without much noise and spark. Any other method as agreed with Engineer-in-Charge may also be used.

5.17 Excavation in areas where existing under ground cables are envisaged, to be carried out carefully by manual means taking proper safety precautions.

The earth work machinery be deployed after ensuring from the trial pits that no cable is crossing the proposed area of excavation.

5.18 Payment (applicable for item rate tenders only)

5.18.1 The payment clause shall be operated only if the earthwork is to be measured separately as per relevant tender item.

5.18.2 Payment for earth work in excavation shall be made on cubic meter (m^3) basis on the measurement of volume of pit/ trench of excavation with working space as per relevant Indian Standards (IS:1200) and slopes/ steppings as permitted by the Engineer-in-Charge. The rate shall include cost of all the operations of blasting with explosives & accessories, making of all

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arrangements for dewatering the accumulated water from any source in the excavated pit or trench, removal and disposal of surplus excavated soil within a lead of 100 m from construction areas. The rate shall also include setting out and line out work required for the excavation.

5.18.3 The following works shall not be measured separately and allowance for the same shall be deemed to have been made in the description of main item:

a) Setting out works, profiles, etc.;
b) Site clearance, such as cleaning grass and vegetation;
c) Unauthorized battering or benching of excavation;
d) Forming (or leaving 'dead men' or 'tell-tales' in borrow pits and their removal after measurements;
e) Forming (or leaving) steps in sides of deep excavation and their removal after measurements;
f) Excavation for insertion of planking and strutting;
g) Unless otherwise specified, removing slips or falls in excavations;
h) Bailing out or pumping of water in excavation from rains;
i) Bailing out or pumping of water in excavation from sub-soil water, and
j) Slinging or supporting pipes, electric cables, etc, met during excavation.

5.18.4 Special pumping other than what is included in 5.18.3 (h and i) and well point dewatering where resorted to, shall each be measured separately, unless otherwise stated, in Kilo Watt Hour against separate specific provision(s) made for the purpose.

5.18.5 The Contractor shall intimate to the Engineer-in-Charge as soon as different classification of soils are met with. The measurements of various soil classifications then shall be worked out by either of the following alternatives in the order of their decreasing importance.

a) Joint levels shall be taken as to the levels of different soil classifications and volume worked out on the basis of levels only.

b) Where levels of different strata cannot be clearly marked and defined, the Contractor shall stack different soils of various classifications separately for measurement purpose and then dispose it off.

c) If the quantum of work involved in (b) above is extensively large & time consuming, then the total area may be divided into various zones and reasonably representative samples as in (b) above may be taken and quantities of soils of various classifications finalized for the entire zone based on the representative.

If soil of any classification other than that specified in the Schedule of Rates is met with during excavation, the decision of the Engineer-in-Charge as to the classification of soil, levels of the strata of different classifications and their location shall be binding.

In above case, the total quantity of excavation shall be computed from the measurement of the pit/ trench excavated. The hard rock and soft rock shall be measured separately from the relevant stacks and each shall be reduced by fifty percent for voids, and paid under the relevant items. The balance, that is the total quantity of excavation minus the reduced (for voids) quantity of excavation for rocks shall be paid as soft/ hard soil as per the direction of the Engineer-in-Charge (However, the maximum payment shall be limited to the volume of the excavated pit/ trench as approved by Engineer-in-Charge).

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6.0 SHORING AND STRUTTING

6.1 The shoring and strutting of the sides to withhold the face of excavation pits/trenches shall be done when approved or directed by the Engineer-in-Charge.

6.2 The shoring shall be of close or open timbering type or by Sheet Piling, Soldier Piling, etc. depending upon the site requirements and as directed by the Engineer-in-Charge whose decision shall be final and binding as to the type of shoring to be used.

6.3 The arrangement of the shoring and strutting shall be sound and safe and shall be got approved from the Engineer-in-Charge before installation. The approval shall not absolve the Contractor of his responsibilities of safety and any other requirements of the contract.

6.4 The shoring and strutting shall be kept in position till all the relevant work in the excavated area is completed and approved. It shall be dismantled and removed only after the permission to do so is obtained from the Engineer-in-Charge.

6.5 Sheet Piling

The contractor shall design, supply and install hot rolled steel sheet piles including all associated structural steel members viz. waler & runner beams, strut, cross ties, vertical members, guide frames, suitable interlocks, suitable corner sections, splicing & cutting of sheet piling. The contractor shall also apply recommended sealant for complete water tightness (as required) and ensure pre-drilling for installation into bedrock (as necessary), etc. as per site conditions.

The contractor shall mobilize/ demobilize all necessary tools & tackles, hammer (vibratory/ impact), crane(s) etc., shifting plant/ machinery and carryout all ancillary works (as required) and ensure subsequent removal of entire arrangement after completion of works.

6.6 Payment (applicable for item rate tenders only)

Payment for shoring and strutting by close and open timbering shall be made on square meter (m^2) basis as separate items. In both the cases, the measurement shall be done on the basis of the surface area of the sides of the excavation actually shored and strutted.

The rate shall include all labour, materials, erection of the poling boards, wales, struts, ballies etc., fixing and keeping the same in position as required, dismantling and removing the same after the work is over as directed.

Payment for shoring and strutting by sheet piling shall be made on the basis of shoring area of sheet pile exposed after complete excavation.

The rate shall include all labour, design, supply and installation of hot rolled steel sheet piles including all associated structural steel members, application of recommended sealant, pre-drilling for installation into bedrock etc., mobilization/ demobilization of all necessary tools & tackles, hammer, crane(s) etc., shifting plant/ machinery & all ancillary works, fixing and keeping the sheet piling in position, dismantling and removing the same after the work is over, etc. all complete as directed by the Engineer-in-Charge.

No extra payment shall be made for cost of extraction and replacement for installing of sheet pile deviating the specification or rejected by Engineer-in-charge. Extracted sheet piles shall be contractor's property and contractor shall remove the same from site without any extra cost to client.

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7.0 BACK FILLING AROUND FOUNDATIONS AND IN PLINTH

7.1 Back filling around completed foundations, structures, trenches and in plinth shall be done to the lines and levels shown on the drawings including any trimming of the surfaces, as may be necessary. This shall be done with selected and approved earth from excavation or otherwise with suitable materials described under Clause 3.1 as directed by the Engineer-in-Charge. Where sufficient suitable material is not available from the excavation, the Engineer-in-Charge may direct to import suitable earth from other sources. The filling shall be done in layers of thickness not exceeding 15 cm with watering, rolling and ramming by manual methods/ mechanical compactors to grade and level as shown on drawings to obtain 90% laboratory maximum dry density.

7.2 The Contractor shall not commence filling in and around any work until it has been permitted by the Engineer-in-Charge.

7.3 Backfilling around liquid retaining structures and pipes shall be done only after approval of the Engineer-in-Charge is obtained.

7.4 **Payment (applicable for item rate tenders only)**

Payment for backfilling with earth shall be based on volume in cubic meters (m^3) of consolidated fill. This volume shall be derived from the difference between the volume of excavation and the structure or trenches as the case may be. The rate shall include cost of extracting suitable approved earth from available excavated soil from spoil heaps within a lead of 100 m, placing, watering, rolling, ramming compacting in layers, trimming and dressing finished surface and disposal of surplus material upto a lead of 100 m.

However, backfilling done with materials other than earth shall be paid separately under relevant items.

8.0 TRANSPORTATION OF SURPLUS EARTH

8.1 Surplus earth and soil from excavation shall be removed from construction area to the area demarcated by the Engineer-in-Charge.

8.2 **Payment (applicable for item rate tenders only)**

8.2.1 Payment shall be made only for the lead beyond initial 100 m from construction area. Rate shall include re-excavation, loading, transportation, dumping, stacking or spreading (as per directions of the Engineer-in-Charge) the surplus earth and the soil in the area demarcated by the Engineer-in-Charge. Payment shall be made on cubic metre (m^3) basis on the difference of measurements of the volume of the excavated pits and the measurement of the back filling. Quantity generated due to voids in back filled volume of earth shall also be removed by the Contractor at no extra cost and this disposal of earth shall not be measured and paid under any item.

8.2.2 In exceptional circumstances the Engineer-in-Charge may direct the Contractor to remove surplus earth, concrete debris or any other waste material from site to the areas of disposal on the basis of truck measurement. In such cases volume of material shall be calculated on the basis of truck volume reduced by 30% for voids in case of soft/hard soils and 50% for soft/ hard rock. All other provisions of disposal such as spreading, levelling, grading shall apply in this case also.

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9.0 PROTECTION OF PROPERTY AND PERSONNEL

9.1 The Contractor shall protect all active utility lines shown on the drawings or encountered during the excavation. If he damages those lines, the Contractor shall repair or replace them. If existing utilities interfere with his work, the Contractor shall inform to the Engineer-in-charge and secure written instructions for further action.

9.2 The Contractor shall barricade open holes and depressions which he creates or exposes as part of this, and he shall post warning signs and lights on property adjacent to or with public access. He shall operate warning lights during hours from dusk to dawn each day and as otherwise required for safety.

9.3 The Contractor shall protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by his operations.

9.4 The Contractor shall plan and execute all aspects of the earthwork so that the safety of personnel, the work and adjacent property is guaranteed and such that a minimum of inconvenience is caused.

10.0 CLEAN UP

Upon completion of work, the Contractor shall leave the project site clear of debris and surplus materials off plant limits in a manner meeting all location authority requirements.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

सादा एवं प्रबलित सीमेंट कंक्रीट

PLAIN AND REINFORCED CEMENT CONCRETE

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
8	07 DEC 22	UPDATED & REVISED	DK	DA	AS	SM
7	29h JAN 16	UPDATED & REISSUED	AJS	AS	RS	SC
6	15th DEC 14	UPDATED & REISSUED	SP	AS	PKM	SC
5	28th DEC 12	UPDATED & REISSUED	CDS	AJS	PKM SC	DM
4	23rd NOV 07	UPDATED & REISSUED	YPC	PKM	VK	VC
3	APR,01	UPDATED & REISSUED	RPM7097	SCS	SCJ1151	MI

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Abbreviations:

ACI	:	American Concrete Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards
GI	:	Galvanized Iron
IS	:	Indian Standard
ISO	:	International Organization for Standardization
PVC	:	PolyVinyl Chloride
RCC	:	Reinforced Cement Concrete
SCC	:	Self Compacting Concrete
SWG	:	Standard Wire Gauge

Structural Standards Committee

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1.0 SCOPE

This specification is applicable for Concrete Grade up to M60 and establishes the requirements of materials, mix proportioning, placing, curing, etc. of all types of cast-in-situ and precast concrete (ref. section 1.6) used in foundations, underground and above ground structures, floors, pavements etc. Any special requirements as shown or noted on the drawings shall supersede the provisions of this specification.

1.1 Reference Codes and Specifications

Apart from this specification, construction of plain and reinforced concrete works shall be in accordance with the Indian Standard Code of Practice for "Plain and Reinforced Concrete" IS 456 along with all amendments till date and other relevant codes mentioned therein.

1.2 For Liquid Retaining Structures, EIL Specification No. 6-68-0005 shall be applicable.

1.3 For Structural Steel works, EIL Specification No. 6-68-0006 & 0008 shall be applicable.

1.4 For Bipolar Concrete Penetrating Corrosion Inhibiting Admixture, EIL Specification No. 6-68-0017 shall be applicable.

1.5 For Self Compacting Concrete, EIL Specification No. 6-68-0019 shall be applicable.

1.6 For precast concrete manufacturing refer EIL Specification No. 6-68-0014.

1.7 In case of conflict between the clauses mentioned in this specification and those in the Bureau of Indian Standards (BIS), this specification shall govern.

2.0 MATERIALS

2.1 Materials for concrete viz cement, Pozzolanas, Fly Ash, Ground Granulated Blast Furnace Slag, Sand, Coarse aggregate, Water, etc. shall be as described in EIL Specification No.6-68-0002.

2.2 Materials for all reinforcements, embedment, inserts, water bars etc. shall conform to EIL Specification 6-68-0002.

2.3 Materials to be used as additive to concrete shall conform to EIL specification 6-68-0002 & 6-68-0017.

3.0 GRADES OF CONCRETE

Characteristic Compressive strength for different grades of concrete shall be as per Table-1.

TABLE – 1
GRADES OF CONCRETE

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm cube at 28 days (N/mm^2)
Ordinary Concrete	M10 M 15 M 20	10 15 20

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TABLE – 1 (CONT.)
GRADES OF CONCRETE

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm cube at 28 days (N/mm^2)
Standard Concrete	M 25	25
	M 30	30
	M 35	35
	M 40	40
	M 45	45
	M 50	50
	M 55	55
High Strength Concrete	M 60	60

Note: 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, all lean/plain concrete shall be of Nominal Mix type and reinforced concrete shall be of Design Mix type.

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 9 of IS 456.

4.3 Design Mix Concrete

The mix shall be designed as per IS: 10262 in an approved laboratory to produce the grade of concrete having the required workability and characteristic strength not less than appropriate values given in Table-1. The target mean strength of concrete mix shall be equal to the characteristic strength plus 1.65 times the standard deviation.

As long as the quality of materials does not change, a mix design done earlier but not prior to one year may be considered adequate for later work. However, in case the source & quality of materials changes or there is a break in the continuity of construction, the Engineer-In-Charge shall ask for a new design mix.

Irrespective of the grade of concrete required to be produced as per characteristic strength criteria, the minimum cement content and maximum water cement ratio in the design concrete shall be strictly maintained as stipulated in Table 5 of IS 456.

5.0 CONCRETE MIX PROPORTIONING

Proportioning, as used in this specification, shall mean the process of determining the proportions of the various ingredients to be used to produce concrete of the required workability when fresh/green and strength, durability & surface finish, when hardened. The following information shall be collected prior to design of the concrete mix:

a) Grade designation.
b) Type of cement.
c) Maximum nominal size of aggregate.
d) Minimum cement content.
e) Maximum water cement ratio
f) Workability requirements.

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g) Exposure condition as per Table 3 & Table 4 of IS 456
h) Maximum temperature of concrete at the time of placing.
i) Method of Placing.

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 tests 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 into consideration for material reconciliation. Preliminary mix designs shall be established well ahead of start of work.

5.1 Maximum Density

Suitable proportions of sand and the different sizes of coarse aggregates for each grade of concrete shall be selected to give as nearly as practicable the maximum density as per clause 10.2.3 of IS 456. This shall be determined by mathematical means, laboratory tests, field trials and suitable changes in aggregate gradation. The contractor shall ensure the same to the satisfaction of Engineer-in-Charge.

5.2 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.

5.3 Workability

"Workability of Concrete" shall be as per clause 7 of IS 456.

5.4 Durability

For achieving sufficiently durable concrete, strong, dense aggregates, low water-cement ratio and adequate cement content shall always be used. Workability of concrete shall be such that 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. 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 and minimum grade of concrete conforming to environmental exposure conditions (refer Table 3 of IS 456) as given in Table 5 of IS: 456.

Generally, following types of cement shall be used for Plain and Reinforced concrete works:

a) 43/ 53 Grade Ordinary Portland Cement conforming to IS 269.
b) Rapid hardening Portland Cement conforming to IS 8041.
c) Portland Slag Cement conforming to IS 455.
d) Portland Pozzolana Cement(fly ash based) conforming to IS 1489(Part 1)
e) Portland Pozzolana Cement (calcined clay based) conforming to IS 1489(Part-2).
f) Sulphate Resisting Portland Cement conforming to IS 12330

Sulphate Resisting Portland Cement shall be used only for specific requirements depending on environmental and process exposure conditions to which the structures may be subjected to like high Sulphate concentrations, processes involving Sulphur handling etc.

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5.4.1 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 be as per Table 5 of IS 456 for different exposure condition.

The minimum cement content as mentioned in Table 5 of IS 456 shall be adjusted for aggregates other than 20 mm nominal maximum size as defined in Table 6 of IS 456.

For maximum cement content refer Cl.8.2.4.2 of IS 456.

5.4.2 Where specified, Bipolar concrete penetrating corrosion inhibiting Admixture in reinforced concrete as per EIL specification No. 6-68-0017 shall be used for protecting the reinforcement from corrosion.

5.5 Limits to Deleterious Constituents

Careful selection of the mix and the constituent materials shall be made to limit the presence of deleterious constituents in concrete. The total acid soluble chloride content calculated from the mix proportion and the measured chloride content of each of the constituents shall not exceed 0.6 kg/m^3 at the time of placing of concrete. The total water soluble Sulphate content of the concrete mix shall not exceed 4 percent by mass of the cement in the mix.

6.0 BATCHING

Refer clause 10.2 of IS 456.

7.0 CONCRETE MIXING

7.1 Ready Mixed Concrete supplied by Ready Mixed Concrete Plants or from on/off-site batching plants (IS 4926) shall be used for structural concrete.

All records and charts for the batching and mixing operations shall be prepared and maintained by the contractor in accordance with IS 4926 or as per the instructions of Engineer-in-Charge.

In case Ready Mixed Concrete is not available, the mixing of concrete shall be strictly carried out in an approved type of mechanical concrete mixer. The mixer shall be fitted with water measuring devices. 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 Mechanical Mixers shall comply with IS 1791 and 12119 and shall be maintained in satisfactory operating condition. These shall be used only for producing lean/ plain concrete and/ or nominal mix concrete wherever permitted.

7.2.2 Mixing Time

Mixing time shall be as indicated in the following Table-2. Excessive mixing requiring additions 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.

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TABLE-2

MINIMUM MIXING TIME FOR MIXERS

Capacity of mixer	Minimum mixing time
2 m^3 or less	2 minutes
Above 2 m^3	3 minutes or as recommended by the mixer manufacturer.

7.3 Hand Mixing

Hand mixing of concrete shall not be permitted. However, for non-critical applications namely foundations for crossovers, isolated operating platforms etc., using concrete upto grade M20 and located at far away isolated places, this may be permitted by the Engineer-in-charge as a special case. Mixing 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.

7.4 Additives

Additive in concrete shall be used only with the prior approval of the Engineer-in-Charge and shall comply with Cl. 5.5 of IS 456. Any additive used for obtaining proper workability or leak proofness of concrete or repair/rendering works of concrete due to non-conformance to the specifications, shall not be measured and paid for. All costs relating to such usage shall be borne by the Contractor.

8.0 TRANSPORTATION, PLACING AND COMPACTION

8.1 General

The entire concrete placing programme including transportation arrangements, deployment of equipment, layout, 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 Chuting

The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization from the Engineer-in-Charge. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer-in-Charge may order discontinuance of their use and the substitution of a satisfactory method of placing the concrete. Open troughs and chutes shall be equipped with baffles and be in short lengths to avoid segregation. Chutes shall be designed so that the concrete is, to some extent, remixed at the lower end by passing down through a funnel shaped pipe or drop chute. Alternatively, they shall discharge into a storage hopper from which the concrete shall be transported to the point of placing by wheel barrows or other means. Where drop chutes are used, a sufficient number of these must be provided, so that the concrete discharged from the chute is not required to flow laterally more than 1.0 metre. Where a drop chute is swung from the vertical, the bottom two sections must be maintained in a vertical position to avoid segregation. The addition of water at any point in the system of transportation, to facilitate the movement of concrete shall not be permitted. All chutes, troughs and pipes, shall be kept clean and free from coatings of hardened concrete by thoroughly flushing them with water after each run; water used for flushing shall be discharged clear of the structure.

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8.1.2 Vibrators

8.1.2.1 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 to 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 shall be used where specifically required and directed by Engineer-in-Charge.

8.1.2.2 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 vibrators 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.

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

8.1.2.4 The vibrator 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.

8.1.2.5 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.

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

8.1.2.7 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 200 mm) surface vibration by such vibrators may be permitted, upon approval of the Engineer-in-Charge.

8.1.2.8 Whenever vibration has to be applied externally, the design of formwork 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 such as formwork as rapidly as possible using suitable buckets, dumpers, pumps, transit mixers 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. For structural concrete produced from Ready Mixed Concrete/ Batching Plants, concrete shall be transported from the plants to the sites only by transit mixers and Delivery Ticket for each delivery of concrete shall be maintained by the contractor.

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.

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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 or 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. Similarly, for concrete to be placed on formworks, all chippings, shavings and sawdust etc. shall be removed from the interior of the forms before the concrete is placed.

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 metre throughout all stages of delivery until the concrete comes to rest in forms. However, drop height can be relaxed by the Engineer-in-Charge as per the provisions given under Cl. 8.1.1. For continuous concreting 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 deposit, 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 shovelling 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 formwork before setting commences and shall not be subsequently disturbed. Methods of placing shall be such as to preclude segregation and avoid displacement of reinforcement or formwork. The formation of stone-pockets or mortar 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.

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8.3.10 Continuous Concreting

Where called out on the drawings, continuous concreting shall be done in a single operation as per the requirements of IS 456 and IS 2974. Sufficient "Windows" shall be left in the formwork for pouring & compaction of concrete and inspection. These windows shall be fixed tight once the level of concrete reaches their levels.

8.3.11 Concreting under special conditions

a) Work in extreme weather conditions during hot or cold weather, the concreting shall be done as per procedure set out in IS 7861(Part 1) or IS 7861 (Part2).

b) Under water concreting shall be as per clause 14.2 of IS 456.

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 works 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 are 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 operations. The Contractor shall take all possible care during concreting to maintain these embedment/inserts in their exact locations.

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 and shall be placed at accessible locations to permit cleaning out of laitance, cement slurry and unsound concrete.

9.2 In a column, the joint shall be formed about 100 mm to 150 mm below the lowest soffit of the beams framing into it. Concrete in a beam and slab shall be placed throughout without a joint but if the provision of a joint is unavoidable, the joint shall be vertical and located within 1/3 to 1/4 of the span, unless otherwise shown on the drawings.

9.3 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 joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop board. Inclined joints 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.

9.4 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. This may be done by manual chipping of concrete, with a high pressure water jet or by any other appropriate means as per Engineer-in-Charge's directions. It shall then be swept clean and thoroughly washed and wetted before any new concrete is poured. Any set mortar or concrete sticking to the exposed reinforcing rods in and around such joints shall be thoroughly removed. The reinforcements shall be wire brushed and washed just before

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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.

9.5 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 aggregate. The 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 thereafter shall proceed in normal way.

10.0 SEPARATION JOINT

10.1 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.

11.0 EXPANSION JOINTS/ISOLATION JOINT

11.1 Expansion/ Isolation joints in structures shall be formed in the positions and to the shapes shown in the relevant drawings. Joints shall be filled with joint filling material as stipulated in the drawings/schedule of rates. Isolation joints shall be provided around all equipment foundations, columns, pedestals, trenches etc. on grade.

12.0 WATER STOPS

PVC water stops as per EIL Specification No. 6-68-0002 for materials shall be accurately cut, fitted and integrally joined as per manufacturer's specifications to provide a continuous, watertight diaphragm at all points.

The water stops shall be located and embedded at expansion/contraction/ construction joints as indicated in the drawings or directed by the Engineer-in-Charge.

Adequate provision shall be made for the support and protection of water stops during the progress of the work. Damaged water stops shall be replaced and/or repaired as directed.

13.0 PROTECTION OF FRESHLY LAID CONCRETE

13.1 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, vibration, abrasion, mixing with deleterious materials that may, in the opinion of the Engineer-in-Charge, impair the strength and/or durability of the concrete.

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14.0 CURING

14.1 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 hours of placement of concrete in normal weather, and in hot weather after 4 hours. 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, sprinklers etc. A layer of sacking, canvas, hessian, or other approved material, which will hold moisture for long periods and prevent loss of moisture from 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 be used. Only approved covering shall be used for curing.

Exposed surfaces of concrete shall be maintained continuously in a damp or wet condition for at least the first 7 days after placing of concrete.

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

For curing the concrete in pavements, floors, flat roofs or other level surfaces, the ponding method of curing shall be used. For the first 24 hours after concreting, the concrete shall be cured by use of wet sacking, canvas, hessian etc. The minimum water depth of 25 mm for ponding shall be maintained. The method of containing the ponded water shall be approved by the Engineer-in-Charge. The ponded areas shall be kept continuously filled with water, and leaks, if any, shall be promptly repaired. Areas cured by ponding method shall be cleared of all debris and foreign materials after curing period is over.

Alternatively, membrane curing may be used in lieu of moist curing with the permission of the Engineer-in-Charge. Such compounds shall be applied to all exposed surfaces of the concrete by spraying or brushing as soon as possible after the concrete has set. Minimum film thickness of such curing compounds shall be as per the recommendation of the manufacturer so as to obtain an efficiency of 90% as specified by BS-8110. This film of curing compound shall be fully removed from the concrete surface after the curing period specified earlier. Engineer-in-Charge may not allow curing by curing compounds for those surfaces where use of curing compound may be detrimental to application of future finishes over the concrete. Impermeable membranes such as polyethylene sheeting closely covering the concrete surface may also be used.

14.2 For concretes containing Portland pozzolana cement or Portland slag cement, the curing period as given in Cl. 14.1 shall be doubled. Curing by ponding shall, however, commence after the first 24 hours of concreting.

15.0 FIELD TESTS

15.1 Materials Testing

15.1.1 Aggregates

Grading test on fine and coarse aggregates shall be carried out as per IS 2386 at intervals specified by the Engineer-in-Charge.

The mandatory tests and their frequencies shall be done as given in Table-3A & 3B below:

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TABLE – 3A
(For Concrete prepared at site by using Mechanical mixers)

MANDATORY TESTS ON SAND & STONE AGGREGATES

S. No	MATERIAL	TEST	FIELD / LAB TEST	MIN. QTY OF MATERIAL/ WORK FOR CARRYING OUT TEST	FREQUENCY OF TESTING*
1.	Sand	(a) Bulking of sand	Field Test	20 m^3	Every 20 m^3 or part thereof or more frequently as decided by the Engineer-in-Charge
		(b) Silt content	Field Test	20 m^3	
		(c) Particle size distribution	Field or Lab as decided by the Engineer-in-Charge	40 m^3	1) Every 40 m^3 of fine aggregate/sand required in RCC works only 2) Every 80 m^3 of fine aggregate/ sand required for other items
2.	Stone aggregate	a) Percentage of soft or deleterious materials	General visual inspection, laboratory test where required by Engineer -in-Charge or as specified	As required by Engineer-in-Charge	For all quantities
		b) Particle size distribution	Field or lab. as required by Engineer-in-Charge	45 m^3	For every 45 m^3 or part thereof as decided by Engineer-in-Charge
		c)Ten percent Fine value	Laboratory	45 m^3	Initial test and subsequent test as & when required by Engineer-in-Charge

* Fresh testing is mandatory whenever there is change in Source of materials.

TABLE – 3B
(Refer Cl. 4.4 & 4.6.1 of IS 4926)

(For Ready Mixed Concrete supplied by Ready Mixed Concrete Plants or from on/off-site Batching Plants)

MATERIALS TESTING REQUIREMENTS

S. No	AGGREGATE PROPERTY/ PARAMETER	TYPE OF AGGREGATE	ASSESSMENT OF TYPICAL PROPERTIES AND HIGH TEST RATE*	NORMAL MONITORING AND LOW TEST RATE*	REQUIREMENT FOR NORMAL MONITORING AND LOW TEST RATE
1.	**Grading**	Sand/Fine	Weekly	Monthly	Last 8 results conform to IS 383 or representative values
		Coarse-Single sized/ Graded	Weekly	Monthly	
2.	**Particle density** -Oven Dry -Saturated Surface Dry -Apparent	All Types	Weekly	3 Monthly	Last 4 results ±0.04 percent
3.	**Absorption**	All Types	Weekly	3 Monthly	Last 4 results ±0.04 percent

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S. No	AGGREGATE PROPERTY/ PARAMETER	TYPE OF AGGREGATE	ASSESSMENT OF TYPICAL PROPERTIES AND HIGH TEST RATE*	NORMAL MONITORING AND LOW TEST RATE*	REQUIREMENT FOR NORMAL MONITORING AND LOW TEST RATE
4.	**Bulk Density** - Loose - Compacted	All Types	Monthly	6 Monthly	Last 4 results ± 75kg/m³
5.	**Fines(Silt) Content**	Sand	Weekly	Monthly	Last 10 results <75 percent maximum allowed
		Coarse	Monthly	3 Monthly	
6.	**Aggregate Impact Value**	Coarse	As specified	As specified	-
7.	**10 % Fines**	Coarse	Yearly	Yearly	-
8.	**Flakiness**	Coarse	2 Weekly	6 Monthly	Last 3 results conform to standard
9.	**Chloride Content**	All Types	Weekly	6 Monthly	Last 3 results < 0.01 percent
10.	**Aggregate Abrasion Value** (Los Angeles Method)	Coarse	-	Yearly/ Source Change	-
11.	**Soundness**	Fine and Coarse	-	Yearly/ Source Change	-
12.	**Potential Alkali Aggregate Reactivity Including Petrography**	Fine and Coarse	-	5 Yearly/ Source Change	-
13.	**Petrographic Description** (General)	All Types	-	5 Yearly	-

***Note** : The high or low test rates apply in accordance with the following conditions:

a) High test rate
   i) To establish the typical characteristics of an aggregate, and
   ii) When significant changes in properties occur outside the tolerances for low test rates given.

b) Low test rate
   i) When the typical characteristics of the aggregate have been established, and
   ii) When subsequent tests lie within the tolerances for low test rates given

15.1.2 Water

The minimum testing frequencies shall be as follows:

SOURCE	PARAMETERS	FREQUENCY	REQUIEMENT
Non mains water (Untreated water extracted from wells, ponds, lakes, rivers, underground, etc.)	p^H value, Chloride ion content, Sulphate content and any other parameter in accordance with IS 456	Initially every week for first 6 weeks (average of test results to be taken) and then at 3-monthly interval	Need further investigation in case significant deviation observed in test results of 3-monthly interval samples from the original 6 weeks average
Mains water (Treated water supplied through piped network)	Same as above	Annual basis once all tests for source are satisfactory	In case Chloride content > 0.01%, testing frequency shall be reduced to 3 months

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15.2 Compaction Factor Test /Slump Test of Concrete

15.2.1 For structural quality concrete (excluding pavements, flooring etc.) 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 by the Engineer-in-Charge.

In case of Ready Mixed Concrete, provisions of IS 4926 shall be followed.

15.2.2 For structural quality concrete for pavements & floorings, measurement of workability shall be by determination of compacting factor. Value of compacting factor of 0.75 to 0.8 shall generally be acceptable.

15.3 Strength Test of Concrete

15.3.1 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.

15.3.2 In order to get a relatively quicker idea of the quality of concrete, optional tests on beams for modulus of rupture at 72±2 hours or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests. For this purpose, the values shall be arrived at based on actual testing. In all cases, the 28 days compressive strength specified in Table-1 shall alone be the criterion for acceptance or rejection of the concrete in accordance with clause 15.3.9.

15.3.3 Sampling Procedure

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

15.3.4 Frequency of Sampling

The minimum frequency of sampling of concrete for each grade shall be in accordance with Table-4.

TABLE – 4
(Refer Cl. 15.2.2 of IS 456)

FREQUENCY OF CONCRETE SAMPLING

Quantity of concrete in the work (m^3)	Number of samples
1-5	1
6-15	2
16-30	3
31-50	4
51 & above	4 plus one additional sample for each additional 50m^3 or part thereof.

At least one sample shall be taken from each shift.

When concrete is produced at continuous production units such as ready mixed concrete/ batching plants, atleast one sample shall be taken for every 50m^3 of concrete or after every 50 batches, whichever occurs at a greater frequency or as decided by the Engineer-in-Charge. Samples shall be avoided from the first and the last cubic metre of concrete mix in a lot.

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15.3.5 Test Specimen

Three test specimens shall be made for 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 check the testing error. Additional samples may also be required for testing samples cured by accelerated methods as described in IS 9013. The specimen shall be tested as described in IS 516.

15.3.6 Identification mark on concrete test cubes:

The following numbering system shall be adopted on each 150 mm cube:

First line: ZZ	(Alpha code assigned by the Engineer -in-Charge to the Contractor for a particular contract starting with AA and progressing to AB, AC and so on).
Second line: XXXX	(Unique integer in ascending order starting from 1).
Third line: DD-MM-YY	(Date of casting of cube)

15.3.7 Test Results of Sample

The test results of the sample shall be the average of the strength of three specimens. The individual variation should not be more than $\pm$ 15 percent of the average. If more, the test results of the sample shall be considered invalid.

15.3.8 Standard Deviation

Standard deviation for each grade of concrete shall be calculated separately.

Standard deviation based on test results of samples:

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

b) For design of mix in the first instance, the value of standard deviation given in Table 8 of IS 456, Amendment No. 4 may be assumed.

c) As soon as sufficient results of samples are available, actual calculated standard deviation shall be used and the mix design shall be revised/ updated. However, when adequate past records for a similar grade exist and justify to the designer a value of standard deviation different from that shown in Table 8 of IS 456, Amendment No. 4, it shall be permissible to use that value.

d) For additional requirement on standard deviation refer clause 9.2.4 of IS 456.

15.3.9 Acceptance Criteria

15.3.9.1 Compressive Strength

The concrete shall be deemed to comply with the strength requirement when both the conditions as given in col. 2 & col.3 of Table-5 for that particular grade of concrete are simultaneously met. For working out standard deviation compressive test result of date wise serially logged 30 sample test result shall be used.

15.3.9.2 Flexural Strength

The concrete shall be deemed to comply with flexural strength requirements when both the following conditions are simultaneously met:

a) The mean strength determined from any group of four non-overlapping consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm^2.

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(For non overlapping consecutive compressive test result any one alternate set of four samples shall be used for verification of compliance to clause no. 16.1.a of IS 456)

b) The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm^2

Table-5
(Refer Cl. 16.1 & 16.3 of IS 456)

Characteristic Compressive Strength Compliance Requirement

Specified Grade	Mean of the Group of 4 Non-Overlapping Consecutive Test Results in N/mm^2	Individual Test Results in N/mm^2
M15 or above	$\geq f_{ck}$ + 0.825 x established standard deviation (rounded off to nearest 0.5N/mm^2) or $\geq f_{ck}$ + 3 N/mm^2, Whichever is greater	$\geq f_{ck}$ – 3 N/mm^2

NOTE : 1) In the absence of established value of standard deviation, the values given in Table 8 of IS 456, Amendment No. 4, may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

2) For concrete of quantity 30 m^3 (where the number of samples to be taken is less than four as per the frequency of sampling given in cl. 15.3.4, Table 4), the mean of test results of all such samples shall be f_{ck} + 4 N/mm^2, minimum and the requirement of individual test results shall be f_{ck} – 2 N/mm^2, minimum. However, when the number of sample is only one as per Table 4, the requirement shall be f_{ck} + 4 N/mm^2.

15.3.9.3 Quantity of Concrete Represented by Strength Test Results

The quantity of concrete represented by group of four consecutive test results shall include the batches from which first and last samples were taken together with all intervening batches. Acceptance of concrete shall be applicable for serially logged 30 samples. In case serially logged samples are less than 30 then standard deviation of adjoining previous sample sets will be used for establishing acceptance criteria as per clause 16.1.a of IS 456.

For the individual test result requirements given in col. 3 of Table-5 or in item (b) of 15.3.9.2, only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified, the maximum quantity of concrete that four consecutive test results represent shall be limited to 60m^3.

15.3.9.4 If the concrete is deemed not to comply pursuant to Cl. 15.3.9.1 or 15.3.9.2, the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken (Refer Cl. 16.0).

15.3.9.5 Concrete of each grade shall be assessed separately.

15.3.9.6 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 tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures and tests to the fullest satisfaction of the Engineer-in-Charge.

15.3.9.7 Tolerance in leveling of concrete surface at foundation/ pedestal top level where grouting is to be done:

Maximum Plan Dimension	≤ 2m	>2m but ≤4m	> 4m
Tolerance in leveling	+ 10 mm	+ 10 mm	+ 10 mm
	- 10 mm	- 20 mm	- 25 mm

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15.3.9.8 Tolerance in dimensions of pocket:

20 mm overall maximum tolerance on the size of pocket.

For pockets, chemically dissolvable moulds shall be preferred. Smooth removal of moulds without affecting the pocket size shall be ensured.

16.0 INSPECTION AND TESTING OF STRUCTURES

16.1 Inspection

To ensure that the construction complies with the design, an inspection procedure shall be set up by the contractor and duly approved by the Engineer-in Charge covering materials used, receipt of materials, their test results, records, workmanship and construction etc.

Contractor shall ensure that the surface which is to receive the grout is at proper level and so are the openings for pockets as per Cl. 15.3.9.7 & 15.3.9.8.

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

16.3 Testing

In case of doubt regarding the grade or soundness of concrete used, either due to poor workmanship or based on results of cube strength, compressive strength tests of concrete on the basis of clause 17.4 of IS 456 and/or load test as per clause 17.6 of IS 456 shall be carried out.

The Engineer-in-Charge shall be the final authority for interpreting the results of all tests and shall decide upon the acceptance or otherwise. The decision of the Engineer-in-Charge shall be final and binding on the contractor. In case the results of the tests are unsatisfactory, the Engineer-in-Charge may instruct the contractor to demolish and reconstruct the structure or part thereof without any extra cost to the Owner.

16.4 Members other than Flexural Members

Members other than flexural members like columns etc. shall be referred to the designer to investigate the structural adequacy. The decision of the designer shall be final and binding on the contractor.

16.5 Non-destructive Tests

Non-destructive tests using Ultrasonic Pulse Velocity and Rebound Hammer methods shall be resorted to for checking the soundness of concrete placed and shall be as per the directions of Engineer-in-Charge. The testing shall be based on IS 13311, Part-1. However, the Rebound Hammer test (IS 13311, Part-2) shall only be used in combination with other tests (Destructive or Non-Destructive) for checking the concrete quality.

17.0 FINISHING OF CONCRETE

17.1 On striking the formwork, 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 is 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 and reconstructing the structure. However, quantity of cement actually used for this purpose may

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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 levelled and 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 bringing excess fine materials to the surface. The top faces of slabs intended to be covered with screed, granolithic or similar finishes, shall be left with a rough finish.

17.2 Repair and Replacement of Unsatisfactory Concrete

17.2.1 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, segregation patches and damaged areas shall be chipped out and the edges undercut slightly to form a key. All loose material 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 and parent concrete shall be obtained by sprinkling dry cement on the wet surface or by throwing mortar with force on to the wetted concrete, or by brush in a coat of thick cement grout of about 1:1 (1 cement:1 sand) just before applying the patching material. Before this has dried, the remainder of the patch shall be filled with mortar or concrete, depending on the extent of the repair.

17.2.2 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 colour 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.

17.2.3 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 100 mm and preferably 150 mm. 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 to maintain the original strength. Additional reinforcement, if required in the patch, shall be provided as per the instructions of Engineer-in-Charge.

17.2.4 In case, in the opinion of the Engineer-in-Charge, defects in the concrete is excessive or beyond repair, the contractor shall 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.

17.2.5 Approved epoxy formulation for bonding fresh concrete used for repairs with already hardened concrete shall be used by the Contractor if asked by the Engineer-in-Charge. Epoxy shall be applied in strict accordance with EIL Specification 6-68-0056 and the instructions of the manufacturer.

17.2.6 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.

17.3 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 hours. Thereafter, the patched area shall be kept continuously wet by a fine spray or sprinkling for not less than 10 days.

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18.0 WATERPROOF CEMENT PAINT

Wherever specified, concrete elements (whether cast-in-situ or precast) exposed to atmosphere shall be provided with three coats of cement based waterproof paint as per IS 5410 provided these surfaces shall not contain any protective coating. Prior to application of the paint, the surface shall be prepared to remove all foreign particles, loose materials, extra deposited concrete lumps, etc. using appropriate mechanical/ manual means.

19.0 FORM WORK

19.1 General

19.1.1 Forms for concrete shall be of plywood conforming to IS 6461 (Part-5) or steel or as directed by the Engineer-in-Charge and shall give smooth and even surface after removal thereof.

19.1.2 If it is desired by Engineer-In-Charge, the Contractor shall prepare, before commencement of actual work, design and drawings for formwork and get them approved by the Engineer-in-Charge. For details regarding design, detailing etc., reference may be made to IS 14687.

19.1.3 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.

(a) Deviation from specified dimensions of cross section of columns and beams. — - 5 mm to +10 mm

(b) Deviation from dimensions of footings (see Note below)

i)	Dimensions in plan	-10 mm to +50 mm
ii)	Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm.
iii)	Thickness	-10 mm to +50 mm or $\pm$0.05 times the specified thickness, whichever is less

Note: These tolerances apply to Cast-in-situ concrete dimensions only, not to positioning of vertical reinforcing steel or dowels.

(c) Deviation in length (major dimension of single unit)

upto 3m	$\pm$6 mm
3m to 4.5m	$\pm$9 mm
4.5m to 6m	$\pm$12 mm
Additional deviation for every subsequent 6m.	$\pm$6 mm

(d) Deviation in straightness or bow (deviation from specified line) for a single or continuous member) e.g. beam, column or slab edge.

upto 3m	6 mm
3m to 6m	9 mm
6m to 12m	12 mm
additional for every subsequent 6m.	6 mm

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(e) Deviation in squareness shall be measured taking the longer of two adjacent sides as the base line.

The shorter side shall not vary in its distance from a perpendicular so that the difference between the greatest and shortest dimensions exceeds 6 mm. For this purpose, any error due to lack of straightness shall be ignored. Squareness shall be checked with respect to the straight lines that are most nearly parallel with the features being checked. When the nominal angle is other than 90 degree, the included angle between check lines shall be varied accordingly.

(f) Deviation in twist shall be within a limit such that any corner shall not be more than the limit given below from the plane containing other three corners:

upto 600 mm wide and upto 6m in length	:	6 mm
over 600 mm wide and for any length	:	12 mm

(g) Maximum deviation in flatness from a 1.5m straight edge placed in any position on a nominally plain surface shall not exceed 6 mm.

(h) Tolerance in leveling of concrete surface at foundation/ pedestal top level where grouting is to be done : As per Cl. 15.3.9.7

19.2 Form Requirement

19.2.1 The formwork shall be true, rigid and adequately braced both horizontally as well as diagonally. The forms shall have smooth and even surface and be sufficiently strong to carry, without deformation, the dead weight of the green concrete, working load, wind load and also the side pressure exerted by the green concrete. As far as practical, clamps shall be used to hold the forms together. Where use of nails is unavoidable minimum number of nails shall be used. Projected part of nail shall not be bent or twisted for easy withdrawal.

19.2.2 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 desired appearance or durability of the structure. No such tie rods shall be used in any liquid retaining or basement structure.

19.2.3 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 17.

19.2.4 Form joints shall not permit any leakage. The formwork shall be strong enough to withstand the effect of vibrations practically without any deflection, bulging, distortion or loosening of its components.

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

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19.2.6 All vertical wall forms may be designed and constructed for the following minimum pressure. The pressures listed in Table-6 are intended as guide only and the Contractor shall ensure that the formwork is adequately strong and sturdy.

TABLE - 6
MINIMUM DESIGN PRESSURE FOR WALL FORMWORK

Rate of pour in meter/hour	Pressure in KN/m^2	
	at 10^0 (in Celsius)	at 24^0 (in Celsius)
0.6	36.0	29.0
0.9	40.0	32.0
1.2	44.0	35.0
1.5	46.0	37.0

All horizontal forms shall be designed and constructed to withstand the dead load of the green concrete, reinforcement, equipment, material, embedment and a minimum live load of 2.0 kN/m^2.

19.3 Inspection of Forms

Temporary openings shall be provided at the base of column and wall forms and other places necessary to facilitate 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 rectified as per the instructions of the Engineer-in-Charge.

19.4 Cleaning and Treatment of Formwork

The surfaces of forms that would come in contact with concrete shall be well treated with approved non-staining form release agents such as soft soap, oil, emulsions etc. Release agents shall be applied so as to provide a thin uniform coating to the forms without coating the reinforcement.

19.5 Chamfers and Fillets

All corners and angles shall be formed with 45 degree mouldings to form chamfers or fillets on the finished concrete. The standard dimensions of chamfers and fillets, unless otherwise detailed or specified shall be 25x25 mm. For heavier work chamfers or fillets shall be 50x50 mm. Care shall be exercised to ensure accurate mouldings. The diagonal face of the moulding shall be planed or surfaced to the same texture as the forms to which it is attached.

19.6 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.

19.7 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.

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Forms and their supports shall not be removed without the approval of the Engineer-in-Charge. Forms shall not be released until the concrete has achieved a strength of at least twice the stress to which the concrete may be subjected at the time of removal. 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. Supports 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 15 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	16 to 24 hours as may be decided by the Engineer-in-Charge.
(b) Slabs (props left under)	3 days.
(c) Beam Soffits (props left under)	7 days.
(d) Removal of props under slabs:	
Spanning upto 4.5m.	7 days.
Spanning over 4.5m.	14 days.
(e) Removal of props under beams and arches:	
Spanning upto 6m	14 days.
Spanning over 6m	21 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:

i) For other cements, the stripping time recommended for ordinary Portland cement shall be suitably modified as per the instructions of the Engineer- in-Charge.

ii) 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 load of the slab, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

iii) Where the shape of the element is such that the formwork has re-entrant angles, the form work shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

iv) For rapid hardening cement, 3/7 of the above mentioned periods shall be considered subject to a minimum of 16 hours.

v) For Portland pozzolana or low heat cement, 10/7 of the above mentioned periods shall be considered.

19.8 Staging/Scaffolding

19.8.1 Staging/Scaffolding shall be properly planned and designed by the Contractor. Use of only steel tubes is permitted for staging/scaffolding. The Contractor shall get it reviewed by Engineer-in-Charge before commencement of work. While designing and during erection of scaffolding/staging, the following measures shall be considered:

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(a) Sufficient sills or underpinnings in addition to base plates shall be provided particularly where scaffolding is erected on soft grounds.

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

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

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

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

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

(g) Wherever the scaffolding/staging is found to be out of plumb line it shall be dismantled and re-erected afresh and effort shall not be made to bring it in line with a physical force.

(h) All nuts and bolts shall be properly tightened and care shall be taken that all clamps/couplings are firmly tightened to avoid slippage

(i) Erection work of a scaffolding/staging under no circumstances shall be left totally to semi-skilled or skilled workmen and shall be carried out under the supervision of a technically qualified civil engineer of the Contractor.

19.8.2 For smaller works or works in remote areas, wooden ballies may be permitted for scaffolding/staging by the Engineer-in-Charge at his sole discretion. The contractor must ensure the safety and suitability of such works as described under clause 19.8.1 above.

20.0 EXPOSED/ARCHITECTURAL CONCRETE WORK

20.1 Form Work

Other things remaining same as per clause 19.0, 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 drawings. The forms shall be butting with each other in straight lines, the corners of the boards being truly at right angles. The joints 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 the pattern of forms impression on the concrete face indicated in the drawings. Maximum care shall be taken to make the form work watertight. Burnt oil shall not be used for treatment of forms. The Contractor shall be permitted reuse of forms brought new on the work place only if forms are properly cared for, stored and treated after each use.

The Engineer-In-Charge may, at his absolute discretion, order removal of any forms considered unsuitable for use in the work.

20.2 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 clause 17.0 with the written permission of the Engineer-in-Charge.

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21.0 REINFORCEMENT

21.1 The Contractor shall develop the bar bending schedule for all RCC structures/ structural parts at no extra cost to the Owner and shall get it reviewed by the Engineer-in-charge. Reinforcement shall be cut and bent to shape as per dimensions shown in the bar bending schedule/ drawings.

If protective fusion bonded epoxy coating is required to be applied on reinforcement bars, the same shall be done as per IS 13620. All repairs to applied protective coating required due to mishandling and/ or bending of reinforcement bars shall also be done as per relevant clauses of IS 13620.

21.2 Straightening, Cutting and Bending

Procedure for cutting and bending shall be as given in IS 2502. Bars shall be bent in a slow and regular movement to avoid fractures by mechanical means only. In case bars are supplied in coils, they shall be smoothly straightened without any kinks.

Cold twisted deformed bars shall be bent cold. Bars larger than 25 mm in size (except cold twisted deformed bars) may be bent hot at cherry red heat to a temperature not exceeding 850^0 Celsius as per the instructions of the Engineer-in-Charge. The bars shall be allowed to cool gradually without quenching.

Bars shall be cut & bend in a Bar Bending Machine. Bars which develops 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 position, care should be taken to ensure that at no time is radius of the bend less than 6 times bar diameter for high strength deformed bars. Care shall also be taken when bending back the dowel bars to ensure that concrete around the bars is not damaged. All bars shall be properly tagged for easy identification.

21.3 Placing and Fixing

All reinforcement shall be cleaned to ensure freedom from loose mill scale, loose rust, oil, form releasing agents, 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. Rough handling and dropping of reinforcement from a height shall be avoided.

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 uncoated reinforcement bars shall be tied at every intersection by two strands of 16 SWG black soft annealed binding wire. The Epoxy coated reinforcement bars shall be tied with 2 strands of PVC coated GI 18 SWG wire at every intersection. 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 sand contents as the concrete which shall be placed) of size 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 1.2m centre to centre.

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b) In case of thick rafts & pile caps having two or multi layers of reinforcement, the vertical distance between the horizontal bars shall be maintained by introducing suitable chairs, spacers, etc.

c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them. The templates shall be removed after the concreting has been done below it.

d) 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 attained sufficient strength so that no movement of the bars in the concrete is possible.

21.4 Special requirements for Handling, Stacking, Placing of Epoxy coated Reinforcing bars.

Epoxy coated reinforcing bars shall be carefully handled and it shall be ensured that these do not rub on any hard surface or against another epoxy coated/uncoated reinforcing bar whether during conveying/transportation, stacking or placing.

During transportation and while stacking the epoxy coated reinforcing bars shall be placed on wooden planks not spaced farther than 600 mm. When placed in stacks the epoxy coated reinforcing bars shall be neatly tied in bundles using PVC binding material.

The cut ends of bars shall be touched up with special touch up material of specifications as provided by the coating agency. After cutting of the bar the application of touch up material shall be completed within four hours.

While bending the bars the pins of work bench(s) shall be provided with a PVC or plastic sleeve. Each bending operation on epoxy coated reinforcing bar shall be completed in time not less than 90 seconds.

Epoxy coated reinforcing steel bar shall not be directly exposed to sun rays or rain, and shall be protected with opaque polyethylene sheets or similar means as approved by the Engineer in Charge.

While doing concreting the workmen or machinery shall not rest or move on the epoxy coated reinforcing bars. Wooden planks shall suitably be placed to create proper gang-way.

21.5 Splicing/Overlapping

Only bars of full length shall be used as shown in the drawings. But where this cannot be done, overlapping of bars shall be done as directed by the Engineer-in-Charge. The overlapping bars shall be tied with two strands of 16 SWG black soft annealed binding wire. The overlaps shall be staggered for different bars and located at points along the span where neither shear nor bending moment is maximum.

21.6 Welded Joints

Welding of reinforcing bars shall not be permitted without the written permission of the Engineer-in- Charge. Where welding of reinforcing bars is permitted, it shall be in accordance with the recommendations of IS 2751 and IS 9417. Welded joints shall be located at suitable staggered positions. Tests shall be made as directed by the Engineer-in-Charge to prove that the joints are of the full strength of the bars. Maximum one welded joint shall be allowed per bar.

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21.7 Mechanical Connections

The mechanical splices in reinforcement by means of couplers, clamps etc. shall be used (as per manufacturer's specifications) with the written approval of the Engineer-in-Charge. Following tests, at the minimum, shall be conducted in advance to prove efficiency of the coupled joint before putting them in actual use. This covers requirements of couplers to be used with bars conforming to grades less than & equal to Fe550D of IS 1786.

Name of the Test	Testing Requirement	Code of conformance
Static Tensile test: 1. Tensile strength	Each connection shall develop at least 125% of the specified yield strength of the reinforcing bar & 100% of the specified tensile strength. Bar break requirement shall be satisfied to avoid splice failure & to develop full tensile strength of the bar.	ASTM A370/ ACI 318/ **AC 133**/ ISO 15835/ IS 16172
Static Tensile test: 2. Percentage elongation (Ductility)	The minimum percentage elongation (at maximum forces), in the reinforcing bar outside the length of the mechanical splice shall be minimum 3% before the failure of the test piece.	ISO 15835 IS 16172
Static compression test	Each connection shall develop atleast 125% of the specified yield strength of the reinforcing bar.	ASTM A370/ ACI 318/ AC 133
Permanent Elongation (Slip)	Permanent elongation across the coupled joint shall be less than 0.1 mm after loading at 60% of the yield strength of the reinforcing bar	BS 8110/ ISO 15835 IS 16172
Cyclic tensile test	Mechanical splice shall withstand 100 cycles of stress variation from 5% to 90% of the yield strength of reinforcing bar & without loss of static tensile strength capacity when compared with like specimen.	IS 16172
Moderate Oligocyclic (Seismic) Test (Cyclic Tension & Compression Test) **(Refer note- 1)**	Deformation across the coupled joint shall be less than 0.3 mm after subjecting the joint to a series of 20 cycles with 95% tension as well as 50% compression of the yield strength of the reinforcing bar & without loss of static tensile strength capacity when compared with like specimen.	ISO 15835/ ASTM A370/ ACI 318/ AC 133
Violent Oligocyclic (Seismic) Test (Cyclic Tension & Compression Test) **(Refer note- 2)**	The joint shall be subjected from zero strain upto twice the yield strain in tension followed by compression stress of 50% of yield strength of reinforcing bar for 4 cycles. Thereafter, from zero strain upto five times the yield strain in tension followed by compression stress of 50% of yield strength of reinforcing bar for 4 cycles. Deformation across the coupled	ISO 15835/ ASTM A370/ ACI 318/ AC 133

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Name of the Test	Testing Requirement	Code of conformance
	joint shall be less than 0.3 mm after 4 cycles & less than 0.6 mm after 8 cycles & without loss of static tensile strength capacity when compared with like specimen.	
Low cycle fatigue test **(Refer note- 3)**	Mechanical splice shall withstand 10,000 cycles of alternating tension & compression load from +173Mpa to -173Mpa & without loss of static tensile strength capacity when compared with like specimen.	IS 16172

Notes-

1) Moderate Oligocyclic (Seismic) test shall be performed for structures in seismic zone II.

2) Violent Oligocyclic (Seismic) test shall be performed for structures in seismic zone III, IV & V.

3) Low cycle fatigue test shall be performed for all structures except for concrete structures which are subjected to high cycle of fatigue like machine foundations etc.. For concrete structures which are subjected to high cycle of fatigue, High cycle fatigue test shall be performed as per IS 16172.

All operations relating to reinforcement coupling shall be done by using manufacturer's patented machine/ equipment in the presence of Engineer-in-Charge. Mechanical connections shall be placed away from points of high stress and shall be staggered.

21.8 Tolerances on Placing of Reinforcement

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

a) For effective depth 200 mm or less $\pm$ 10 mm

b) For effective depth more than 200 mm $\pm$ 15 mm

21.9 Substitution

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

21.10 Tolerance to Cover

The actual concrete cover shall not deviate from the required nominal cover by + 10 mm measured over the steel reinforcement including links.

22.0 PAYMENT

22.1 Plain and Reinforced Concrete

22.1.1 Payment for plain and reinforced cement concrete shall be made on cubic metre basis of the volume of the actual finished work done or as per approved construction drawings, whichever is less and shall be inclusive of providing pockets, openings, recesses of all sizes, chamfers, fillets, grooves, separation/ expansion/ isolation/ construction/ movement joints, curing by normal moist curing or using curing compound etc. as directed by Engineer-in-Charge etc. The rates shall be deemed to include complete cost of getting the

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respective mix designs approved, making and testing concrete cubes and carrying out other tests including tests of various ingredients, as per specifications and as directed by Engineer-in-Charge. Payment shall, however, be separately made for tests on concrete cubes done by accelerated methods of curing as defined in IS 9013.

22.1.2 No separate payment shall be made for any additive/ admixture/ Plasticizer/ Fibres used by the contractor for accelerating or retarding the strength of concrete or for achieving specified workability. The rate quoted shall be deemed to be inclusive of all costs related to any such additive/admixture/ Plasticizer/ Fibres.

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

22.1.4 Where the strength of concrete mix as indicated by tests, lies in between the strengths of any two grades given in Table-1 and it is accepted by the Owner/Engineer-in-Charge, such concrete shall be classified as a grade belonging to the lower of the two grades between which it lies. In case the cube 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. The concrete giving lower strength than specified may be accepted at reduced rates after satisfying the safety of the structure by checking it with tests as specified or rejected entirely at the discretion of the Engineer-in- Charge. 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 and 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. In case the concrete of lower strength can be improved by carrying out some strengthening measures entirely at the discretion of the Engineer-in-Charge, then the said measures including all related tests shall be carried out by Contractor at his own cost. If the Contractor is able to make up the strength to the required grade by such improvement measures to the entire satisfaction of Engineer-in-Charge, payment shall be made for the grade achieved. However, if the strength of concrete is not made up to the strength of required grade, payment shall be made only for the lower strength if such concrete is accepted by the Engineer-in-Charge.

22.1.5 Deductions for openings, pockets etc. shall be as specified in relevant parts of IS 1200.

22.1.6 The rate quoted for reinforced cement concrete, also includes single pour concreting wherever specified. The rate shall be inclusive of all extra cost related to labour, shuttering, staging and making all other arrangements for such continuous casting e.g. provisions for adequate movement and storage spaces, special gangways, scaffolding, additional construction equipments, adequate lighting and supervision while the work continues round the clock etc. The rate shall also be inclusive of all costs related to concreting in any thickness, shape and position and at any height or depth so as to avoid any cold joint between specified construction joints.

22.1.7 Form Work

Unless otherwise specified, payment for form work shall be on square metre basis of the actual area in contact with the concrete cast. The rates 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 rates shall be inclusive of any provision to be made or kept in the formwork for providing dowels, inserts etc.

Superior quality formwork for exposed/architectural concrete work shall be measured and paid separately under the relevant item in the schedule of rates.

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22.2 Reinforcement

22.2.1 Payment for plain round mild steel reinforcement bars, high strength deformed steel bars and epoxy coated reinforcing steel bar shall be on the basis of weight of bare steel irrespective of any coating applied in metric tons. The weight of the bar shall be derived from the sizes and corresponding nominal unit weight given in Table-1 of IS 1786. In case actual unit weight of the bars is less than nominal unit weight, but within permissible tolerances, the weight of reinforcement shall be calculated on the basis of actual unit weight. In case actual unit weight of the bars is more than nominal unit weight, the payment shall be made on the basis of nominal unit weight. Standard hook lengths, chairs, spacer bars and authorized laps only shall be included in the weight calculated. Binding wire shall not be weighed nor otherwise measured. Measurements for weight shall not include cutting allowance etc.

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

22.2.3 Payment for a mechanical threaded coupler/ clamp shall be made by measuring the Lap length of the respective rebar on which coupler/ clamp is used. The rate shall include supply of complete assembly, fixing, testing etc. all complete.

22.3 Water Stops/Water Bars & Expansion/Isolation Joints

22.3.1 Payment for water bars shall be made on running metre (RM) basis of the water stops provided in position. Rate shall include supplying, cutting, fixing, jointing by vulcanising or any other approved method, wastage, etc. complete.

22.3.2 Payment for filler materials in Expansion/Isolation joints shall be made on running metre basis of the joint provided. For boards provided at expansion/isolation joints, the measurement shall be made on square metre basis. Rate shall be inclusive of supply, cutting, fixing, jointing, wastage etc. complete.

22.4 Waterproof Cement Paint

22.4.1 Payment for waterproof cement paint as per Cl. 18.0 shall be made separately on Sqm basis.

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मानक विनिर्देश
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

संरचनात्मक इस्पात कार्य

STRUCTURAL STEEL WORKS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
8	13.05.25	UPDATED & REISSUED	RIYA	VIKRAM	AS	MN
7	13.01.20	UPDATED & REISSUED	TK	AJS	RS	RK TRIVEDI
6	26.08.14	UPDATED & REISSUED	SP	AS	PKM	S CHANDA
5	18.06.09	REAFFIRMED & REISSUED	AS	PKM	VINAY KUMAR	N. DUARI
4	18.04.00	UPDATED & REISSUED	DPN	RS	SCJ	MI
3	MAY'94	UPDATED & REISSUED	DPN	RS	GPL	A. SONI

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Abbreviations:

AFC	:	Approved For Construction
AWS	:	American Welding Society
BIS	:	Bureau of Indian Standards
IS	:	Indian Standards

Structural Standards Committee:

Convenor: Mr. Anurag Sinha

Members:
Mr. Virender Goel
Mr. Deepak Agrawal
Ms. Alpana Srivastava
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1.0 SCOPE

This specification describes the information to be included in a Project Specification and also covers the requirements for material, storage, preparation of fabrication drawings, fabrication, assembly, tests/examinations, transportation, erection and painting of all types of bolted and/or welded structural steel works for general construction work. Fabrication of structures shall also include fabricating:

(a) Built up sections/plate girders made out of rolled section and/or plates.

(b) Compound sections made out of rolled sections.

2.0 REFERENCES

2.1.1 BIS Codes

IS 800, IS 808, IS 816, IS 819, IS 822, IS 919, IS 1024, IS 1261, IS 1323, IS 1477, IS 1852, IS 2074, IS 7205, IS 7215, IS 7307, IS 7310, IS 7318, IS 9595 and other relevant BIS Codes.

2.1.2 International Standard

AWS D1.1 Structural Welding Code - Steel

2.2 EIL Specifications

6-68-0002- Materials
6-79-0020 (or relevant Job Specification) – Surface preparation & protective coating

2.3 In case of conflict between the clauses mentioned in this specification and those in the Indian Standards, this specification shall govern. Any special provision as shown or noted on the design drawings or any project specific specification specified elsewhere shall govern over the provisions of this specification.

3.0 MATERIALS

3.1 General

All materials shall conform to their respective specifications given in EIL Specification no. 6-68-0002. The use of equivalent or alternative materials shall be permitted only in very special cases and for all such cases prior written approval of the Engineer-in-Charge shall be obtained.

3.2 Receipt & Storing of Materials

3.2.1 Each section shall be marked for identification and each lot shall be accompanied by manufacturer's quality certificate, chemical analysis and mechanical characteristics.

3.2.2 All sections shall be checked, sorted out and arranged by grade and quality in the store. Any instruction given by the Engineer-in-Charge in this respect shall be strictly followed.

3.2.3 All material shall be free from surface defects such as pitting, cracks, laminations, twists etc. Defective material shall not be used and all such rejected material shall be immediately removed from the store/site. The decision of the Engineer-in- Charge in this regard shall be final and binding.

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3.2.4 Welding wires and electrodes (packed in their original cartons) shall be stored separately by quality and lots inside a dry and enclosed room in compliance with IS 9595 and as per the instructions given by the Engineer-in-Charge. Electrodes shall be kept perfectly dry to ensure satisfactory operation and weld metal soundness.

3.2.5 Each lot of electrodes, bolts, nuts etc. shall be accompanied by manufacturer's quality/test certificates.

3.2.6 All bolts (including nuts & washers) shall be checked, sorted out and arranged diameter-wise by grade and quality in the store.

3.3 Material Tests

3.3.1 The Contractor shall submit manufacturers' quality certificates for all the materials supplied by him. In case, quality certificates are not available or are incomplete or when material quality differs from standard specifications, such materials shall not be used in the construction. However, the Contractor shall get all appropriate tests conducted in approved test houses for such materials as directed by the Engineer-in-Charge, at no extra cost, and submit the same to Engineer-in-Charge for his approval. The Engineer-in-Charge may approve the use of such materials entirely at his discretion.

3.3.2 The Contractor shall ensure that all materials brought to site are duly approved by the Engineer-in-Charge. Rejected materials shall not be used and shall be removed from site forthwith. Any material of doubtful quality for which specific tests are to be carried out as per the instruction of the Engineer-in-Charge shall be separately stacked and properly identified and shall not be used. These shall be removed from site forthwith.

4.0 FABRICATION DRAWINGS

4.1 Fabrication and erection drawings shall be prepared by the Contractor on the basis of "Approved for Construction" (AFC) design drawings, EIL Standards issued to the Contractor. These drawings shall be prepared by Contractor or by an agency engaged by the contractor using TEKLA or AUTODESK Advance Steel or equivalent 3D Modeling software and approved by the Engineer-in-Charge.

4.2 Fabrication and erection drawings shall be thoroughly checked, stamped "Approved for Construction" and signed by the Contractor's own responsible Engineer irrespective of the fact that such drawings are prepared by the Contractor or his approved agency, to ensure accuracy and correctness of the drawings. Unchecked and unsigned drawings shall not be used for the purpose of proceeding with the work. The Contractor shall proceed with the fabrication and erection work only after thoroughly satisfying himself in this regard.

4.3 All fabrication and erection drawings shall be issued for construction by the Contractor directly to his work- site. Six copies of such drawings shall simultaneously be submitted to the Engineer-in-Charge who may check/ review some or all such drawings at his sole discretion and offer his comments for incorporation in these drawings by the Contractor.

However, the Contractor shall not proceed with the fabrication of such structures whose fabrication drawings are required to be reviewed before taking up the fabrication work as noted on "Approved for Construction (AFC)" design drawings issued to the Contractor or as conveyed by the Engineer-in-Charge. The fabrication of such structures shall be done only as per the reviewed fabrication drawings.

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The review of such drawings by EIL shall be restricted to the checking of the following only:

i) Structural layout, orientation and elevation of structures/members.

ii) Sizes of members.

iii) Critical joint details.

4.4 Fabrication drawings shall be drawn to scale and shall convey the information clearly and adequately. Following information shall be furnished on such drawings:

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

ii) Structural layout, elevations & sections (with distinct erection marking of all members).

iii) Framing plans, member sizes, orientation and elevations.

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

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

vi) Location, type, size and dimensions of welds and bolts.

vii) Shapes and sizes of edge preparation for welding.

viii) Details of shop and field joints/welds.

ix) Bill of materials/D.O.D. Lists.

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

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

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

xiii) Details of holes and fittings in components necessary for safe lifting and erection purpose.

4.5 The Contractor shall additionally ensure accuracy of the following and shall be solely responsible for the same:

i) Provision for erection and erection clearances.

ii) Marking of members

iii) Cut length of members

iv) Matching of joints and holes.

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v) Provision kept in the members for other interconnected members.

vi) Bill of materials/D.O.D. Lists.

4.6 Connections, splices and other details where not shown on the design drawings shall be suitably designed and shown on the fabrication drawings based on good engineering practice developing full member strength. **Design calculations for such connections/ splices shall be submitted to the Engineer-in-Charge along with the fabrication drawings.**

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

4.8 In case during execution of the work, the Engineer-in-Charge on review of drawings considers any modifications/ substitutions necessary to meet the design parameters/ good engineering practice, these shall be brought to the notice of the Contractor who shall incorporate the same in the drawings and works without any extra cost to the owner. The Contactor will be totally responsible for the correctness of the detailed fabrication drawings and execution of the work.

4.9 Contractor shall incorporate all the revisions made in the design drawings during the course of execution of work in his fabrication drawings, and resubmit the drawings at no extra cost to the Owner. All fabrication shall be carried out only as per the latest AFC design drawings and corresponding fabrication drawings.

4.10 The Contractor shall supply two prints each of the final/as built drawings along with their native soft file to Engineer-in-Charge for reference and record. The rates quoted shall include for the same.

5.0 FABRICATION

5.1 General

5.1.1 Fabrication of structures shall be done strictly as per "Approved for Construction" fabrication drawings (prepared by the Contractor based on the latest design drawings) and in accordance with IS 800, 9595 & other relevant BIS Codes.

5.1.2 Prior to commencement of structural fabrication, undulations in the fabrication yard, if any, shall be removed and area levelled and paved by the Contractor.

5.1.3 Any defective material used in the work shall be replaced by the Contractor at his own expense. Necessary care and precautions shall be taken so as not to cause any damage to the structure during any such removal and replacement.

5.1.4 Any faulty fabrication pointed out at any stage of work by the Engineer-in- Charge, shall be made good or replaced by the Contractor at his own cost.

5.1.5 Tolerances for fabrication of steel structures shall be as per IS 7215.

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5.2 Fabrication Procedure

5.2.1 Straightening & Bending

5.2.1.1 All materials shall be straight and, if necessary, before being worked shall be straightened and/or flattened (unless required to be of curvilinear form) and shall be free from twists.

5.2.1.2 Bending of rolled sections and plates shall be done by cold process to shape/s as shown on drawings.

5.2.1.3 After completion of bending or straightening, welds within the area of bending or straightening shall be thoroughly visually inspected. Nondestructive tests required to be carried out for such locations shall be done only after straightening or bending activity.

5.2.2 Clearances

The erection clearance for cleated ends of members shall be not greater than 2mm at each end. The erection clearance at ends of beams without web cleats and end plates shall be not more than 3mm at each end but where for practical reasons, greater clearance is necessary, suitably designed seatings approved by the Engineer-in-Charge shall be provided.

5.2.3 Cutting

5.2.3.1 Prior to cutting, all members shall be properly marked showing the requisite cut length/width, connection provisions e.g. location and dimensions of holes, welds, cleats etc. Marking for cutting shall be done judiciously so as to avoid wastages or unnecessary joints as far as practicable. Marking shall be done by placing the members on horizontal supports/pads in order to ensure accuracy. Marking accuracy shall be limited to + 1mm.

5.2.3.2 Cutting may be affected by shearing, cropping or sawing. Gas cutting by mechanically controlled torch shall be permitted for mild steel. Hand flame cutting may be permitted subject to the approval of the Engineer-in-Charge.

5.2.3.3 Except where the material is subsequently joined by welding, no loads shall be transmitted into metal through a gas cut surface.

5.2.3.4 Shearing, cropping and gas cutting shall be clean, square, free from any distortion & burrs, and should the Engineer-in-Charge find it necessary, the edges shall be ground afterwards, to make the same straight and uniform at no extra cost to the Owner.

5.2.4 Making Holes

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

5.2.4.2 Holes through more than one thickness of material of members such as compound stanchions and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped/bolted together. Punching may be permitted before assembly, provided the thickness of metal is less than 16mm and the holes are punched 3mm less in diameter than the required size and reamed, after assembly, to the full diameter. Punching shall not be adopted for dynamically loaded structures.

5.2.4.3 Holes may be drilled in one operation through two or more separable parts and burrs removed from each part after drilling.

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5.2.4.4 Holes in connecting angles and plates, other than splices, also in roof members and light framing, may be punched full size through material not over 12mm thick, except where required for close tolerance bolts or barrel bolts.

5.2.4.5 All matching holes for black bolts shall register with each other so that a gauge of 2mm less in diameter than the diameter of hole shall pass freely through the assembled members in the direction at right angle to such members. Finished holes shall be not more than 2mm in diameter larger than the diameter of the black bolt passing through them, unless otherwise specified by the Engineer- in-Charge.

5.2.4.6 Holes for turned and fitted bolts shall be drilled to a diameter equal to the nominal diameter of the shank or barrel subject to H8 tolerance specified in IS 919. Parts to be connected with close tolerance or barrel bolts shall be firmly held together by tacking bolts or clamps and the holes drilled through all the thicknesses in one operation and subsequently reamed to size. Holes not drilled through all the thicknesses in one operation shall be drilled to a smaller size and reamed out after assembly. Where this is not possible, the parts shall be drilled and reamed separately.

5.2.4.7 To facilitate grouting, holes shall be provided in column bases or seating plates exceeding 300mm in width for the escape of air.

5.2.4.8 To avoid accumulation of water in gusseted column bases of laced, battened or box type stanchions, suitable reverse U-type holes shall be provided at the junction of base plate and column section in the vertical gussets for draining out of any water.

5.2.4.9 Slotted holes shall be punched or formed by drilling two holes and completed by cutting.

5.2.5 **Assembly**

The component parts shall be assembled and aligned in such a manner that they are neither twisted nor otherwise damaged, and shall be so prepared that the required camber, if any, is provided. Proper clamps, clips, jigs and other fasteners (bolts and welds) shall be placed in a balanced pattern to avoid any distortion in the members and to ensure their correct positioning (i.e. angles, axes, nodes etc.). Any force fitting, pulling/stretching of members to join them shall be avoided. Proper care shall be taken for welding shrinkage & distortion so as to attain the finished dimensions of the structure shown on the drawings.

5.2.6 **Welding**

5.2.6.1 **General**

a) All joints shall be welded unless noted otherwise on the design drawings.

b) Welding shall be in accordance with IS 816, IS 819, IS 1024, IS 1261, IS 1323 and IS 9595 as appropriate.

c) The Contractor shall make necessary arrangement for providing sufficient number of welding sets of the required capacity, all consumables, cutting and grinding equipment with requisite accessories/ auxiliaries, equipment & materials required for carrying out various tests such as dye penetration, magnetic particle, ultrasonic etc.

d) Adequate protection against rain, dust, snow & strong winds shall be provided to the welding personnel and the structural members during welding operation. In the absence of such a protection no welding shall be carried out.

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e) It shall be the responsibility of the Contractor to ensure that all welding is carried out in accordance with the terms of this specification and relevant BIS codes. The Contractor shall provide all the supervision to fulfil this requirement.

5.2.6.2 **Preparation of Member for Welding**

a) **Edge Preparation**
Edge preparation/bevelling of fusion faces for welding shall be done strictly as per the dimensions shown in the drawings. In case, the same are not indicated, edges shall be prepared (depending on the type of weld indicated in the drawing) as per the details given in IS 9595. Bevelling of fusion faces shall be got checked and approved by the Engineer- in-Charge. The tolerances on limits of gap, root face & included angle shall be as stipulated in IS 9595.

b) **Cleaning**

Welding edges and the adjacent areas of the members (extending upto 20mm) shall be thoroughly cleaned of all oil, grease, scale and rust and made completely dry. Gaps between the members to be welded shall be kept free from all foreign matter.

c) **Preheating**

Preheating of members, shall be carried out as per IS 9595 when the base metal temperature is below the requisite temperature for the welding process being used. Preheating shall be done in such a manner that the parts, on which the weld metal is being deposited, are above the specified minimum temperature for a distance of not less than 75mm on each side of the weld line. The temperature shall be measured on the face opposite to that being heated. However, when there is access to only one face, the heat source shall be removed to allow for temperature equalization (1 minute for each 25mm of plate thickness) before measuring the temperature.

d) **Grinding**

i) Column splices & butt joints of struts and compression members (depending on contact for load transmission) shall be accurately ground and close-butted over the whole section with a tolerance not exceeding 0.2mm locally at any place. In column caps & bases, the ends of shafts together with the attached gussets, angles, channels etc., shall be accurately ground so that the parts connected butt over minimum 90% surface of contact. In case of connecting angles or channels, care shall be taken so that these are fixed with such accuracy that they are not reduced in thickness by grinding by more than 2mm.

ii) Ends of all bearing stiffeners shall be ground to fit tightly at both top and bottom. Similarly bottom of the knife edge supports along with the top surface of column brackets shall be accurately ground to provide effective bearing with a tolerance not exceeding 0.2mm locally at any place.

iii) Slab bases and caps shall be accurately ground over the bearing surfaces and shall have effective contact with the ends of stanchions. Bearing faces which are to be grouted direct to foundations need not be ground if such faces are true & parallel to the upper faces.

iv) Tack welding shall be thoroughly removed by grinding or gouging such that subsequent welding shall be done properly.

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5.2.6.3 **Welding Processes**

Welding of various materials under this specification shall be carried out using one or more of the following processes.

- Manual Metal Arc Welding Process (MMAW)
- Submerge Arc Welding Process (SAW)
- Gas Metal Arc Welding Process (GMAW)
- Flux Cored Arc Welding Process (FCAW)

The welding procedure adopted and consumables used shall be specifically approved by the Engineer-in-Charge. A combination of different welding processes or a combination of electrodes of different classes/makes may be employed for a particular joint only after qualifying the welding procedures to be adopted and obtaining the written approval of the Engineer-in-Charge.

5.2.6.4 **Approval & Testing of Welders**

The Contractor shall satisfy the Engineer-in-Charge that the welders are suitable for the work upon which they will be employed. For this purpose, the welders shall have satisfied the relevant requirements of IS 7318 or AWS D1.1. If the welders will be working to approved welding procedures, they shall have satisfied the relevant requirements of IS 7310 or AWS D1.1.

Adequate means of identification shall be provided to enable each weld to be traced to the welder by whom it was made. The Contractor shall intimate the Engineer-in-Charge sufficiently in advance, the commencement of tests, to enable him to be present to witness the same.

5.2.6.5 **Approval & Testing of Welding Procedures**

The Contractor shall carry out procedure tests in accordance with IS 7307 or AWS D1.1 to demonstrate by means of a specimen weld of adequate length on steel representative of that to be used, that he can make welds with the welding procedure to be used for the work to the complete satisfaction of the Engineer- in-Charge. The test weld shall include weld details from the actual construction and it shall be welded in a manner simulating the most unfavourable instances of fit-up, electrode condition etc., which are anticipated to occur on the particular fabrication. Where material analysis is available, the welding procedure shall be carried out on material with the highest carbon equivalent value.

After welding, but before the relevant tests given in IS 7307 or AWS D1.1 are carried out, the test weld shall be held as long as possible at room temperature, but, in any case not less than 72 hours, and shall then be examined for cracking. The examination procedure shall be sufficiently rigorous to be capable of revealing significant defects in both parent metal and weld metal.

After establishing the welding method, the Contractor shall finally submit to the Engineer-in-Charge for his approval the welding procedure specification in standard format given in IS 9595 before starting the fabrication.

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5.2.6.6 **Sequence of Welding**

a) As far as practicable, all welds shall be made in a sequence that will balance the applied heat of welding while the welding progresses.

b) The direction of the general progression in welding on a member shall be from points where the parts are relatively fixed in position with respect to each other towards points where they have a greater relative freedom of movement.

c) All splices in each component part of a cover-plated beam or built up member shall be made before the component part is welded to other component parts of the member.

d) Joints expected to have significant shrinkage shall be welded before joints expected to have lesser shrinkage.

e) Welding shall be carried continuously to completion with correct number of runs.

f) The Contractor shall choose the welding sequence after carefully studying each case such as to minimize distortion and shrinkage & submit the same to the Engineer-in-Charge for comments and approval.

5.2.6.7 **Welding Technique**

a) After the fusion faces are carefully aligned and set with proper gaps, the root pass of butt joints shall be executed properly so as to achieve full penetration with complete fusion of the root edges.

b) On completion of each run, all slag and spatters shall be removed and the weld and the adjacent base metal shall be cleaned by wire brushing and light chipping. Visible defects such are cracks, cavities and other deposition faults, if any, shall be removed to sound metal before depositing subsequent run of weld.

c) All full penetration butt welds shall be completed by chipping/gouging to sound metal and then depositing a sealing run of weld metal on the back of the joints. Where butt welding is practicable from one side only, suitable backing steel strip shall be used and joint shall be arranged in such a way as to ensure that complete fusion of all the parts is readily obtained.

d) While welding is in progress care shall be taken to avoid any kind of movement of the components, shocks, vibrations to prevent occurrences of weld cracks.

e) Any deviation desired from the recommended welding technique and electrodes shall be adopted only after obtaining written approval of the Engineer-in-Charge.

5.2.6.8 **Inspection & Testing of Welds**

The method of inspection shall be according to IS 822 and extent of inspection and testing shall be in accordance with the relevant applicable standard or, in the absence of such a standard, as specified by the Engineer-in-Charge. Welds shall not be painted or otherwise obscured until they have been inspected, approved and accepted.

The Engineer-in-Charge or his representative shall have access to the Contractor's work at all reasonable times and the Contractor shall provide him with all facilities necessary for

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inspection during all stages of fabrication and erection with, but not limited to, the following objectives.

i) To check the conformity with the relevant standards and suitability of various welding equipments and their performance.

ii) To witness/approve the welding procedure qualification.

iii) To witness/approve the welders performance qualification.

iv) To check whether shop/field welding being executed is in conformity with the relevant specifications and codes of practice.

Inspection and testing of all fabricated structures shall be carried out by the Contractor by any, or, a combination of all the following methods as directed by the Engineer-in-Charge and no separate payment shall be made, unless otherwise mentioned, for inspection and testing of welds/fabricated structures:

A. Visual Inspection

All finished welds (i.e. 100 percent) shall be visually inspected for identification of the following types of weld defects & faults.

a) Weld defects occurring at the surface such as blow holes, exposed porosity, unfused welds etc.

b) Surface cracks in the weld metal or in the parent metal adjacent to it.

c) Damages to the parent metal such as undercuts, burning, overheating etc.

d) Profile defects such as excessive convexity or concavity, overlapping, unequal leg lengths, excessive reinforcement, incompletely filled grooves, excessive penetration beads, root grooves etc.

e) Distortion due to welding i.e., local shrinkage, camber, bowing, twisting, rotation, wariness etc.

f) Linear eccentric, angular and rotational misalignment of parts.

g) Dimensional errors.

B. Mechanical Tests

The mechanical testing (such as tensile load tests, bend tests, impact tests etc.) shall be done in accordance with the relevant standards and as per the instructions of the Engineer-in-Charge.

C. Magnetic Particle/Dye Penetration/Ultrasonic Examination

The examination shall be done at random as directed by the Engineer-in-Charge. Whenever such tests are directed, the tests shall be carried out on joints chosen by him. The tests shall be carried out by employing approved testing procedure in accordance with IS 822.

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D. Radiographic Examination

Radiographic examination shall be carried out only in special cases for random joints as directed by the Engineer-in-Charge. The Contractor shall be paid extra for such examination except for penalty radiographic tests for which the cost shall be borne by him. The Contractor shall make necessary arrangement at his own expense for providing the radiographic equipment, films and all other necessary materials required for carrying out the examination. The tests shall be carried in the presence of the Engineer-in-Charge by employing approved testing procedure in accordance with IS 822. The Contractor shall fulfill all the statutory safety requirements while handling X-ray and Gamma-ray equipment and provide the Engineer- in-Charge all the necessary facilities at site such as dark room, film viewer etc., to enable him to examine the radiographs.

5.2.6.9 **Repair of Faulty Welds**

No repair of defective welds shall be carried out without proper permission of the Engineer-in-Charge and his approval for the corrective procedure.

Welds not complying with the acceptance requirements (as specified by BIS Codes & the Engineer-in-Charge), as revealed during inspection & testing of welds or erection or in-situ condition, shall be corrected either by removing & replacing or as follows:

a) Excessive convexity	- Reduced to size by removal of excess weld metal.
b) Shrinkage cracks, cracks in in parent plates and craters	- Defective portions removed down to sound metal and re-welded.
c) Under cutting.	- Additional weld metal deposited.
d) Improperly fitted/ misaligned parts.	- Welding cut & edges suitably prepared and parts.
e) Members distorted by the heat of welding	- Member straightened by mechanical means or careful application of limited amount of heat, temperature of such area not to exceed 650 degree Centigrade (dull red heat).

In removing defective parts of a weld, gouging, chipping, oxygen cutting or grinding shall not extend into the parent metal to any substantial amount beyond the depth of weld penetration, unless cracks or other defects exist in the parent metal. The weld or parent metal shall not be undercut in chipping, grinding, gouging or oxygen cutting.

Any fabricated structure or its component which, in the opinion of Engineer- in-Charge, is defective and/or beyond any corrective action shall be removed forthwith from the site as instructed by the Engineer-in-Charge without any extra claim. The owner reserves the right to recover any compensation due to any loss arising out of such rejections.

5.2.7 **Bolting**

5.2.7.1 All bolts shall be provided such that no part of the threaded portion of the bolts is within the thickness of the parts bolted together. Washers of suitable thickness shall be used under the nuts to avoid any threaded portion of the bolt being within the thickness of parts bolted together.

5.2.7.2 The threaded portion of each bolt shall project through the nut at least one thread.

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5.2.7.3 Flat washers shall be circular and of suitable thickness. However, where bolt heads/nuts bear upon the bevelled surfaces, they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

5.2.7.4 Different bolt grades of the same diameter shall not be used in the same structure, except if agreed otherwise by the Engineer-in-Charge.

5.2.7.5 Bearing type bolts shall be used (unless noted otherwise) and tightened firmly by available means.

5.2.8 **Splicing**

5.2.8.1 Splicing of built up/compound/latticed sections shall be done in such a fashion that each component of the section is joined in a staggered manner.

5.2.8.2 Where no butt weld is used for splicing, the meeting ends of two pieces of joist/channel/built up section shall be ground flush for bearing on each other and suitable flange and web splice plates shall be designed and provided for the full strength of the flange/ web of the section and welds designed accordingly.

5.2.8.3 Where full strength butt weld is used for splicing (after proper edge preparation of the web and flange plates) of members fabricated out of joist/ channel/ angles/ built up section, additional flange and web plates shall be provided, over and above the full strength butt welds, to have 40% strength of the flange and web.

5.2.8.4 Where a cover plate is used over a joist/channel section the splicing of the cover plate and channel/joist sections shall be staggered by minimum 500mm. Extra splice plate shall be used for the cover plate and joist/channel section as per clause 5.2.8.2 or 5.2.8.3.

5.2.8.5 Prior approval shall be obtained by the Contractor for locations of splices where not shown on design drawings. For members upto a length of 7m, generally no splice shall be allowed but in exceptional cases one splice shall be allowed at approved location. Maximum two numbers of splices shall be allowed for members exceeding this length.

5.2.9 **Machining & Grinding**

5.2.9.1 All slab bases and slab caps shall be accurately machined over the bearing surfaces and shall be in effective contact with the ends of column sections (shafts).

5.2.9.2 For slab bases and slab caps, ends of column shafts shall be accurately machined. However, for gusseted bases and caps, the column shafts shall be ground flush for effective contact with parts connected together.

5.2.9.3 Gusseted bases and caps shall be ground flush for effective contact with ends of column sections.

5.2.9.4 End of all bearing stiffeners shall be machined or ground to fit tightly at top and bottom without any air gap.

5.2.9.5 While machining or grinding care shall be taken so that the length or thickness of any part does not get reduced by more than 2.0mm.

5.2.9.6 For all machining or grinding works for gusseted base and cap plates, the clearance between the parts joined shall not exceed 0.2mm at any location.

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6.0 MARKING FOR IDENTIFICATION

6.1 Each component shall be distinctly marked (with paint) before delivery in accordance with the marking diagrams and shall bear such other marks as will facilitate erection. Components which are identical in all respects may have the same erection mark.

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

7.0 SHOP ERECTION

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

8.0 INSPECTION & TESTING OF STRUCTURES

8.1 The Engineer-in-Charge (or his authorised representative) shall have free access at all times to those parts of the Contractor's works which are concerned with the fabrication of the steel work and shall be provided with all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of these specifications & other relevant BIS Codes.

8.2 Should any structure or part of a structure be found not to comply with any of the provisions of this specification (or relevant BIS Codes as referred to), it shall be liable to rejection. No structure or part of the structure, once rejected shall be resubmitted for inspection, exception cases where the Engineer-in-Charge or his authorised representative considers the defect as rectifiable.

8.3 Defects which may appear during/after fabrication/ erection shall be made good only with the consent of the Engineer-in-Charge and procedure laid down by him.

8.4 All necessary gauges and templates shall be supplied free to the Engineer-in-Charge by the Contractor whenever asked for during inspection. The Engineer-in- Charge, may at his discretion, check the test results obtained at the Contractor's works by independent tests at a test house, and the cost of such tests shall be borne by the Contractor.

9.0 SHOP PAINTING

9.1 All components and members of steel work shall be given one shop coat of primer, as specified in the tender, immediately after the surfaces have been properly prepared (i.e. degreased, derusted, descaled & cleaned) in accordance with the job specification or 6-79-0020, as applicable.

The primer coat shall be applied over completely dry surfaces (using brushes of good quality) in a manner so as to ensure a continuous and uniform film without "holidaying". Special care shall be taken to cover all the crevices, corners, edges etc. However, in areas which are difficult to reach by brushing, daubers/mops shall be used by dipping the same in paint and then pulling/ pushing them through the narrow spaces. The primer coat shall be air dried and shall have the thickness as per EIL Specification no. 6-79-0020 or the relevant job specification.

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9.2 Surfaces which are inaccessible after shop assembly, shall receive the full specified protective treatment before assembly (this shall not apply to the interior of sealed hollow sections).

9.3 Steel surfaces shall not be painted within a suitable distance of any edges to be welded if the paint specified would be harmful to welders or impair the quality of the welds.

9.4 Welds and adjacent parent metal shall not be painted prior to deslagging, inspection and approval by the Engineer-in-Charge.

9.5 Parts to be encased in concrete shall have only one coat of primer and shall not be painted after erection.

10.0 PACKING

10.1 All items shall be suitably packed in case these are to be despatched from the fabrication shop to the actual site of erection so as to protect them from any damage/distortion or falling during transit. Where necessary, slender projecting parts shall be temporarily braced to avoid warping during transportation.

10.2 Small parts such as gussets, cleats etc., shall be securely wired on to their respective main members.

10.3 Bolts, nuts washers etc. shall be packed in crates.

11.0 TRANSPORTATION

Loading and transportation shall be done in compliance with transportation rules. In case, certain parts can not be transported in the lengths stipulated on the drawings, the position details of such additional splice joints shall be got approved by the Engineer-in- Charge.

12.0 SITE (FIELD) ERECTION

12.1 Plant & Equipment

The suitability and capacity of all plant and equipment used shall be to the complete satisfaction of the Engineer-in-Charge.

12.2 Storing & Handling

All steel work shall be so stored and handled at site so that the members are not subjected to surface abrasion, excessive stresses and any damage.

12.3 Setting Out

Prior to setting out of the steel work, the Contractor shall get himself satisfied about the correctness of levels, alignment, location of existing concrete pedestals/columns/brackets and holding down bolts/pockets provided therein. Any minor modification in the same including chipping, cutting and making good, adjusting the anchor bolts etc., if necessary, shall be carried out by the Contractor at his own expense. The positioning and levelling of all steel work including plumbing of columns and placing of every part of the structure with

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accuracy shall be in accordance with the drawings and to the complete satisfaction of the Engineer-in-Charge.

12.4 Tolerances

Tolerances for erection of steel structures shall be as per Annexure 'A'

13.0 SAFETY & SECURITY DURING ERECTION

13.1 The contractor shall comply with IS 7205 for necessary safety and adhere to safe erection practices and guard against hazardous as well as unsafe working conditions during all stages of erection.

13.2 During erection, the steel work shall be securely bolted or otherwise fastened and when necessary, temporarily braced/guyed to provide for all loads to be carried by the structure during erection till the completion, including those due to the wind, erection equipment & its operation etc. at no extra cost to the owner. For the purpose of guying, the Contractor shall not use other structure in the vicinity without prior written permission of the Engineer-in-Charge.

13.3 No permanent bolting or welding shall be done until proper alignment has been achieved.

13.4 Proper access, platform and safety arrangement shall be provided for working and inspection, (at no extra cost to the owner) whenever required.

14.0 FIELD CONNECTIONS

14.1 Field Bolting

Field bolting shall be carried out with the same care as required for shop bolting.

14.2 Field Welding

All field assembly and welding shall be executed in accordance with the requirements for shop assembly and welding. Holes for all erection bolts - where removed after final erection shall be plugged by welding. Alternatively, erection bolts may be left and secured.

15.0 GROUTING

15.1 Prior to positioning of structural columns/girders/ trusses over the concrete pedestals/columns/brackets, all laitance & loose material shall be removed by wire brushing & chipping. The bearing concrete surfaces shall be sufficiently levelled, hacked with flat chisels to make them rough, cleaned (using compressed air) and made thoroughly wet. All pockets for anchor bolts shall also be similarly cleaned and any excess water removed. Thereafter, the structural member shall be erected, aligned & plumbed maintaining the base plates/shoe plates at the levels shown in the drawings, with necessary shims/pack plates/wedges.

15.2 After final alignment and plumbing of the structure, the forms shall be constructed alround and joints made tight to prevent leakage. Grouting (under the base plates/shoe plates including grouting of sleeves & pockets) shall be done with non-shrink grout having compressive strength (28 days) not less than 40N/sq.mm. Non shrink grout shall be of free

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flow premix type and of approved quality and make. It shall be mixed with water in proportion as specified by the manufacturer. Ordinary 1:2 cement/sand mortar grout shall be used only for small, isolated structures e.g. operating platforms not supporting any equipment, pipe supports, crossovers, stairs & ladders. The thickness of grout shall be as shown on the drawings. In case, not mentioned grout thickness shall not be less than 25mm nor more than 50mm in any case.

15.3 The grout mixture shall be poured continuously (without any interruption till completion) by grouting pumps from one side of the base plate and spread uniformly with flexible steel strips and rammed with rods, till the space is filled solidly and the grout mixture carried to the other side of the base plate.

15.4 The grout mixture shall be allowed to harden for a period as decided by the Engineer-in-Charge. At the end of this period, the shims/wedges/pack plates may be removed and anchor bolts tightened uniformly. The alignment of the structure shall now be rechecked and if found correct, the voids left by the removal of shims/wedges/pack plates (if removed) must be filled up with a similar mixture of grout. In case after checking, serious misalignment is indicated, the grout shall be removed completely and fresh grouting done after making appropriate correction of alignment.

16.0 SCHEME AND SEQUENCE OF ERECTION

The Contractor shall furnish the detailed scheme and sequence of erection to match with the project schedule and get the same approved by the Engineer-in- Charge. All necessary co-ordination and synchronization shall be done with the Civil contractor where Civil works are not included in the scope of structural contractor at no extra cost so as to match with the project schedule.

17.0 PAYMENT

This clause shall apply to Item Rate tender only.

17.1 Payment for structural steel works shall be made on the basis of admissible weight in metric tons (determined as described in clause 17.2 and 17.3) of the structure accepted by the Engineer-in-Charge. The rate shall include supplying (as per supply conditions given in the Tender) fabricating, erecting in position (at all levels & locations), testing/examining (excluding radiography only) of bolted and/or welded structural steel works of all types (including all built up/compound sections made out of rolled sections and/or plates) including all handling, transporting, storing, straightening if required, cutting, edge preparation, preheating, bolting and welding of joints (including sealing the joints of box sections with continuous welding), finishing edges by grinding/machining as shown, fixing in line & level with temporary staging & bracing and removal of the same after erection, grouting with non-shrink/ordinary grout as specified, preparation of fabrication & erection drawings, & erection schedule and getting them reviewed, preparation and submission of as built drawings, preparing the surfaces for painting, and applying the primer as specified after fabrication, return of surplus materials to owner's stores and material reconciliation in the case of materials supplied by the owner as per relevant contract conditions etc. all complete for all the operations mentioned in the foregoing clauses.

17.2 The weight for payment shall be determined from the fabrication drawings and respective bill of materials prepared by the Contractor. The bill of materials shall be checked and approved by the Engineer-in-Charge before making the payment. The Contractor shall prepare full scale template in order to supplement/verify the actual cutting dimensions

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where so directed by the Engineer-in-Charge. The weight shall be calculated on the basis of BIS Hand Book wherever applicable. In case sections used are different from BIS sections, then Manufacturers' Hand Book shall be adopted. No allowance in weight shall be made for rolling tolerances.

17.3 Welds, bolts, nuts, washers, shims, pack plates, wedges, grout and shop painting shall not be separately measured. The quoted rate shall be deemed to include the same.

17.4 The rate shall include all expenses related to safety & security arrangements during erection and all plants & tools required for fabrication, transportation & erection.

18.0 PAINTING AFTER ERECTION

18.1 General

18.1.1 The scope of painting after erection shall be at the sole discretion of the Engineer-in-Charge and the Contractor shall obtain written instruction in this regard sufficiently prior to taking up any procurement of paint and execution of painting work after erection of steel structures.

18.1.2 The Contractor shall carry out the painting work in all respects with the best quality of approved materials (conforming to relevant EIL Specification no. 6-79-0020 or the job specification, as applicable) and workmanship in accordance with the best engineering practice. The Contractor shall furnish characteristics of paints (to be used) indicating the suitability for the required service conditions. The paint manufacturer's instructions supplemented by Engineer-in-Charge's direction, if any, shall be followed at all times. Particular attention shall be paid to the following:

- Proper storage to avoid exposure & extremes of temperature.
- surface preparation prior to painting.
- Mixing & thinning.
- Application of paint and the recommended limit on time intervals between consecutive coats.

18.1.3 Painting shall not be done in frost or foggy weather, or when humidity is such as to cause condensation on the surfaces to be painted.

18.1.4 Surface which shall be inaccessible after site assembly shall receive the full specified protective treatment before assembly.

18.1.5 Primers & finish coat paints shall be from the same manufacturer in order to ensure compatibility. Painting colour code shall be as per Annexure-'B' or the job specification.

18.2 Rub Down & Primer Application

The shop coated surfaces shall be rubbed down thoroughly with emery/abrasive paper to remove dust, rust, other foreign matters and degreased, if required, in accordance with EIL specification no. 6-79-0020 or the job specification, as applicable, cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry.

Primer coat as per EIL specification no. 6-79-0029 or the job specification, as applicable, shall be applied by brushing/ spraying over the shop coat in a manner so as to ensure a continuous and uniform film throughout. Special care shall be taken to cover all the crevices, corners, edges etc. The final primer coat shall be air dried and shall have a

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minimum film thickness as per EIL Specification no. 6-79-0020 or job specification after drying, as applicable.

In case different cleaning procedure & primer specifications are specified in the drawing/Tender, the same shall be adopted.

18.3 Final Paint Application

After the primer is hard dry, the surfaces shall be dusted off and the paint as per EIL specification no. 6-79-0020 or the job specification, as specified, shall be applied by brushing/spraying so that a film free from "holidaying" is obtained. The colour & shade of first coat of paint shall be slightly lighter than the second coat in order to identify the application of each coat. The second coat of paint shall be applied after the first coat is hard dry. The minimum thickness of each film shall be 20 microns (± 10% tolerance) after drying.

In case a different type of paint & painting procedure are specified in the drawing/tender, the same shall be adopted.

18.4 Inspection & Testing of Painting Works

18.4.1 All painting materials including primers & thinners brought to site by the Contractor for application shall be procured directly from reputed and approved manufacturers and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates shall not be accepted.

18.4.2 The Engineer-in-Charge at his discretion may call for additional tests for paint formulations. The Contractor shall arrange to have such tests performance including batch wise test of wet paints for physical & chemical analysis. All costs shall be borne by the Contractor.

18.4.3 The painting work shall be subject to inspection by the Engineer-in-Charge at all times. In particular, the stage inspection will be performed and Contractor shall offer the work for inspection and approval at every stage before proceeding with the next stage. The record of inspection shall be maintained. Stages of inspection are as follows:

(a) Surface preparation
(b) Primer application
(c) Each coat of paint

18.4.4 Any defect noticed during the various stages of inspection shall be rectified by the Contractor to the entire satisfaction of the Engineer-in-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work the Contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period, as defined in General Conditions of Contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat. The thickness shall be measured at as many locations as decided by the Engineer-in-Charge. The Contractor shall provide standard thickness measuring instrument such as elkometer (with appropriate range for measuring dry film thickness of each coat) free of cost to the Engineer-in-Charge whenever asked for.

18.5 Payment

Payment for painting of structural steel works shall be made on the basis of admissible weight in metric tons of the painted structures accepted by the Engineer-in-Charge.

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The rate shall include supplying & applying the paint, specified in the tender, of approved quality and shade over the primer, specified in the tender, over the shop primer already applied to structural steel works of all types/shapes at all levels, locations & positions including storage, surface preparation, degreasing, cleaning, drying, touching up of shop primer coat, providing temporary staging, testing etc. all complete to the entire satisfaction of the Engineer-in-Charge.

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ANNEXURE-'A'
(Clause 12.4)

Maximum Permissible Erection Tolerances

A.	**Columns**	
1.	Deviation of column axes at foundation top level with respect to true axes.	
	i) In longitudinal direction	± 5 mm
	ii) In lateral direction	± 5 mm
2.	Deviation in the level of bearing surface of columns at foundation top with respect to true level	± 5 mm
3.	Out of plumb (Verticality) of column axis from true vertical axis, as measured at top:	
	i) Upto and including 30m height whichever is less.	± H/1000 or ± 25 mm
	ii) Over 30m height	± H/1200 or ± 35 mm whichever is less.
4.	Deviation in straightness in longitudinal & transverse planes of column at any point along the height.	± H/1000 or ± 10 mm whichever is less.
5.	Difference in the erected positions of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance.	± 5 mm
6.	Deviation in any bearing or seating level with respect to true level.	± 5 mm
7.	Deviation in difference in bearing levels of a member on adjacent pair of columns both across & along the building.	+ 5 mm

Note: 1. Tolerance specified under 3 should be read in conjunction with 4 & 5.
Note: 2. 'H' is the column height in mm.

B.	**Trusses**	
1.	Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord.	± 1/250 of height of truss in mm at centre of span or ± 15mm whichever is less.
2.	Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss.	± 1/1500 of span of truss in mm or ± 10mm Whichever is less.
3.	Lateral shift in location of truss from its true position.	± 10mm

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4.	Lateral shift in location of purlin from true position.	± 5mm
5.	Deviation in difference of bearing levels of truss from the true level.	± 1/1200 of span of truss in mm or 20mm whichever is less.

C. Gantry Girders & Rails

1.	Shift in the centre line of crane rail with respect to centre line of web of gantry girder.	$\pm [\{\frac{\text{web thickness (mm)}}{2}\}+2 \text{ mm}]$
2.	Shift of alignment of crane rail (in plan) with respect to true axis of crane rail at any point.	± 5 mm
3.	Deviation in crane track gauge with respect to true gauge.	
	i) For track gauge upto and including 15 m.	± 5 mm.
	ii) For track gauge more than 15m. Subject to maximum ± 10mm, where S in metres is true gauge.	± [5 + 0.25 (S-15)]
4.	Deviation in the crane rail level at any point from true level.	± 10 mm.
5.	Difference in level between crane track rails (across the bay) at	
	i) Supports of gantry girders	15 mm.
	ii) Mid span of gantry girders	20 mm.
6.	Relative shift of crane rail surfaces (at a joining) in plan and elevation.	2 mm.

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ANNEXURE-'B'
(Clause 18.1)

PAINTING COLOUR CODE FOR STRUCTURAL STEEL

1.	GANTRY GIRDER & MONORAIL	DARK GREEN
2.	GANTRY GIRDER & MONORAIL STOPPER SIGNAL	RED
3.	BUILDING STRUCTURAL STEEL COLUMNS, BRACKETS, BEAMS, BRACINGS, ROOF TRUSS, PURLINS, SIDEGIRTS, LOUVERS, STRINGERS	DARK ADMIRALITY GREY
4.	PIPE RACK STRUCTURE & TRESTLE	DARK ADMIRALITY GREY
5.	CHEQUERED PLATE (BOTH FACES)	BLACK
6.	GRATING	BLACK
7.	LADDER RUNGS	BLACK VERTICALS & CAGE RED
8.	HAND RAILING	
	- HANDRAIL, MIDDLE RAIL, TOE PLATE	SIGNAL RED
	- VERTICAL POST	BLACK

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

विभिन्न इस्पात कार्य

MISCELLANEOUS STEEL WORKS

Rev. No	Date	Purpose	Prepared by	Checked by	Reviewed by	Approved by
8	18.04.25	REVISED & REISSUED	TK	AJS	AS	MN
7	27.08.18	REVISED & REISSUED	AS	AS	RS	RKT
6	24.01.14	REVISED & REISSUED	AJS	RS	PKM	SC
5	10.06.08	REVISED & REISSUED	PKB	PKM	VK	VC
4	18.04.00	UPDATED & REISSUED	DPN	RS	SCJ	MJ

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Digitally signed by MD MAZHER ALI
Date: 2026.03.17 18:09:31 IST
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