



Project Title: Design, Supply, Installation, Testing & Commissioning of Fire-fighting system and associated facilities including Operation & Maintenance for a period of five years as per OISD-156 at Oil Jetty No. 08, Kandla, of Deendayal Port Authority

Document Title: Vol III of III Technical Specifications

TECHNICAL SPECIFICATIONS FOR CIVIL WORKS

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PART – I MATERIALS

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01 CIVIL

01.01 GENERAL

01.01.01 Scope



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This part deals with the requirements of materials for use in construction work with regard to quality, testing, approval and storage, before they are used on work. This part is supplementary to Part-II: Workmanship and Other requirements of the Technical Specifications for civil works.

01.02 Standard

A high standard of quality is required for all materials used in construction work. They shall be the best of the kind obtainable indigenously in each case and shall be procured from manufacturers of repute in order to ensure uniformity of quality and assurance of timely supply.

01.03 Approval and Tests

01.03.01 All materials to be used in construction shall be subject to approval of the Engineer. The Contractor shall apply sufficiently in advance with samples of the materials including the supporting test results from the approved laboratory and other documentary evidence from the manufacturer wherever applicable and indicating the types of materials and their respective sources. The delivery of materials at site shall commence only after the approval of the quality, grading and sources of the materials by the Engineer.

01.03.02 The quality of all materials once approved shall be maintained throughout the period of construction and periodical tests shall be carried out to ensure that it is maintained. Such routine tests shall be listed under the different materials and/or as may be ordered by the Engineer from time to time.

01.03.03 Where a particular "Brand" or "Make" of material is specified in the Schedule of Items or Technical Specifications, such "Brand" or "Make" of material alone shall be used on the work. Should it become necessary for any reason (such as nonavailability/ceased to be produced), to use any material other than the specified "Brand" or "Make", the Contractor shall submit sample of the same to the Engineer for approval together with test certificates and other documents necessary for examining and giving approval thereof. Should such change or substitution of materials, subsequently approved, results in use of material of price lower than that of the material specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately reduced. Similarly, in case the substitution results in use of material of price higher than that specified in the Schedule of Items or Technical Specifications, the rates of work affected by the substitution shall be proportionately increased.

01.04 Codes

01.04.01 The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

01.04.02 In case of any conflict in meaning between these specifications and those of BIS or IRC, or British /International Standard; the provisions of these specifications shall prevail.

01.05 Rejection of Materials



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01.05.01 Any material brought to site which, in the opinion of the Engineer is damaged, contaminated, deteriorated or does not comply with the requirement of this specification shall be rejected.

01.05.02 If the routine tests or random site tests show that any of the materials, brought to site, do not comply in any way with the requirements of this specification or of I.S. Codes as applicable, then that material shall be rejected.

01.05.03 The Contractor at his own cost shall remove from site any and all such rejected material within the time specified by the Engineer.

01.06 Materials for concrete

01.06.01 Aggregates

Aggregates shall comply with the requirements of IS: 383-1970 "Coarse and Fine Aggregates for Concrete". They shall be hard, strong, dense, durable, clean and free from veins and adherent coating, vegetable matter and other deleterious substances; and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregates which are chemically reactive with alkalis of cement shall not be used. Aggregates which are not sufficiently clean shall be washed in clean fresh water to the satisfaction of the Engineer.

01.06.02 Testing

All aggregates shall be subject to inspection and testing. The Contractor shall submit samples for testing as may be required by the Engineer. Sampling and testing shall be carried out in accordance with IS: 2386-1963 "Methods of Test for Aggregates for concrete".

01.06.03 Grading

The Contractor shall ensure that the full range of aggregate used for making concrete is graded in such a way as to ensure a dense workable mix. The delivery of aggregates will commence only when the Engineer has approved the samples and the quality and grade shall be maintained consistent and equal to the approved sample. Before construction commences, the Contractor shall carry out a series of tests on the aggregates and on the concrete made there from to determine the most suitable grading of the available aggregates. Once the most suitable grading has been found, the grading shall be adopted for the construction of the works and periodic tests shall be carried out to ensure that it is maintained.

Size and grading of fine aggregates

The grading shall conform to IS: 383-1970 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 150 micron sieve or having the fineness modulus less than 2 shall not be used for concrete work.

Size and grading of coarse aggregates



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The nominal maximum size of the aggregates for each mark of concrete or for each type of work shall depend upon the description of the particular item in the Schedule of Items and/or according to relevant clauses of IS: 456-2000. The aggregates shall be well graded and the grading shall conform to relevant requirements of IS: 383-1970 depending upon the maximum nominal size as specified or as required.

Fine aggregate for mortar and grout

The grading of fine aggregate for mortar and grout shall be within the limits of grading zone III and IV as defined in IS: 383-1970.

01.06.04 Storage & stacking

Care shall be taken in the storage to avoid intrusion of any foreign materials into the aggregates and where two types of aggregates are stored close to each other, they shall be separated by a wall or plate. In case of stockpiling, care shall be taken to avoid forming pyramids resulting in segregation of different sized materials. The height of the stacks shall be generally limited to 150 cm.

01.07 Coarse Aggregates

01.07.01 Types

The type of coarse aggregate viz., stone chips, gravel or broken brick shall be as described in the Schedule of Items. Unless otherwise specified in the Schedule of Items, stone chips shall be used as coarse aggregate.

01.07.02 Stone chips

It shall be crushed or broken from hard stone obtained from approved quarries of igneous or metamorphic origin. The stone chips shall be hard, strong, dense, durable and angular in shape. It shall be free from soft, friable, thin, flat, elongated or laminated and flaky pieces and free from dirt, clay lumps, and other deleterious materials like coal, lignites, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability of concrete. The total amount of deleterious /foreign materials shall not exceed 5% by weight according to relevant clause of IS: 383-1970. If found necessary the stone chips shall be screened and washed before use.

01.08 Fine Aggregates

01.08.01 Unless specified otherwise it shall either be natural river sand or pit sand.

Sand shall be clean, sharp, strong, angular and composed of hard siliceous material. It shall not contain harmful organic impurities in such form or quantities as to affect adversely the strength and durability of concrete. Sand for reinforced concrete shall not contain any acidic or other impurities which is likely to attack steel reinforcement. The percentage of all deleterious materials including silt, clay etc., shall not exceed 5% by weight. If directed, sand shall be screened or washed before use to the satisfaction of Engineer.

01.08.02 Crusher dust



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Crusher stone dust (that is retained on 300 micron sieve) may be used as replacement for certain quantum of sand aiming to improve the fineness modulus of fine aggregate. The quantum of replacement for sand shall be arrived at by suitable trial mixes. The Engineer will decide the final usage of crusher dust depending on the circumstances.

01.08.03 Cement

Ordinary Portland cement / Portland slag cement complying with the requirements of IS:269-1989 and I.S. 455-1989 respectively shall be used for making plain and reinforced concrete, cement grout and mortar.

Other types of cement may be used depending upon the requirements of certain jobs with the approval of the Engineer. These shall conform to the following standards:

Portland Pozzolana Cement	IS: 1489-1991
Rapid Hardening Portland Cement	IS: 8041-1990
43 Grade Ordinary Portland Cement	IS: 8112-1989
53 Grade Ordinary Portland Cement	IS: 12269-1987
Hydrophobic Portland Cement.	IS: 8043-1991
High alumina cement for structural work	IS: 6452-1989
White Portland cement	IS: 8043-1989
Sulphate Resisting Portland Cement	IS: 12330-1988

01.09 Testing of samples

The Contractor shall supply a copy of the manufacturer's test certificate for each consignment of cement supplied by him and consignments shall be used on work in the order of delivery. The Contractor shall supply samples of cement to the Engineer as frequently as he may require for testing. The sampling of cement for testing shall be according to IS: 3535-1986. All tests shall be in accordance with the relevant clauses of IS: 4031 (Part-I to Part-15) 1988 to 1991 & IS: 4032-1985.

01.09.01 Contractor's responsibility

From the time a consignment of cement is delivered at site and tested and approved by the Engineer until such time as the cement is used on the works, the Contractor shall be responsible for keeping the same in sound and acceptable condition and at his expense and risk. Any cement which deteriorates while in the Contractor's charge and is rejected as unsuitable by the Engineer, shall be removed from the site to outside the limits of work at the cost of contractor within two days of ordering such removal by the Engineer.

01.09.02 Stock of cement



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In order to ensure due progress, the Contractor shall at all times maintain on the site at least such stock of cement as the Engineer may from time to time consider necessary. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.

01.09.03 Storage of cement

The cement shall be stored in such manner as to permit easy access for proper inspection and in a suitable weather-tight, well ventilated building to protect it from dampness caused by ingress of moisture from any source. Different types of cement shall be stored separately. Cement bags shall be stacked at least 15 to 20 cm clear of the floor leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high. Each consignment of cement shall be stacked separately to permit easy access for inspection.

01.10 Water

Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than '6'. Water has to meet the requirements mentioned in clause 4.3 of IS: 456-2000. Water shall be obtained from an approved source.

Where it is obtained from a source other than a supply main, it shall be tested to establish its suitability. Water for construction purpose shall be stored in proper storage tanks to prevent any organic impurities getting mixed up with it.

01.11 Admixture for Concrete

01.11.01 Approval

Admixtures to concrete shall not be used without the written consent of the Engineer. When permitted, the Contractor shall furnish full details from the manufacturer and shall carry out such test as the Engineer may require before any admixture is used in the work.

01.11.02 Types

Integral water proofer

Admixtures used as integral water proofer shall be free of chlorides and sulphates and shall conform to IS: 2645-1975. The application and doses shall be as per manufacturer's specification.

01.12 Interval of Routine Test

The routine tests of materials, delivered at site, shall be at the following intervals:

Aggregates - Fortnightly or for every 200 m³ for each aggregate whichever is earlier and in other respects generally as per IS: 2386 (Part 1 to 8)- 1963.

Cement - Fortnightly or for each consignment, within 4 days of delivery and in other respects generally as per IS: 4031-1988.



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Water - Once in two months for each source of supply and in other respects generally as per IS: 456-2000.

Reinforcement - For each consignment within 4 days of delivery in accordance with I.S. 1786-1985, I.S. 1599-1985 and I.S. 1608-1972.

01.13 Steel

01.13.1 For Reinforcement

Reinforcing bars for concrete shall be round steel bars of the following types as may be shown on the drawing:

- i) Plain mild steel bars conforming to Grade-I of IS: 432-1982 "Mild Steel & Medium Tensile Steel for Concrete Reinforcement".
- ii) "High strength deformed steel bars conforming to IS: 1786-2008 for Concrete Reinforcement".
- iii) Reinforcement fabrics conforming to IS:1566-1982 "Hard Drawn Steel Wire Fabric for Concrete Reinforcement"

All reinforcement bars shall be of uniform cross sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Unit weight of reinforcement bars conforming to I.S. 1786 is as given below.

Nominal Size (Dia)	Mass Per Metre Run (mm) (Kg)
6	0.222
8	0.395
10	0.617
12	0.888
16	1.580
18	2.000
20	2.470
22	2.980
25	3.850
28	4.830
32	6.310

01.13.02 Binding wire

Binding wire for reinforcement shall be annealed steel wire 20 BWG conforming to IS: 280 - 2006 "Specification for Mild Steel Wire".



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01.13.03 Light structural work and inserts

Steel for light structural work and for preparation of inserts and embedments shall conform to IS: 2062-2006 "Steel for general structural purposes - Specification."

01.13.04 Steel Tubes

Steel tubes for use in light structural work and inserts shall be of light or medium class (as may be specified in drawings or the schedule of items) and of grade YST 25 conforming to IS : 1161 - 1998 "Specification for Steel Tubes for Structural Purposes".

01.13.05 Foundation Bolts

Bolts to be embedded in concrete shall, unless otherwise detailed in drawings, conform to IS: 5624-1993 "Specification for Foundation Bolts". Material for bolts, shall, unless otherwise mentioned in drawings or the schedule of items, be of steel conforming to IS: 2062-2006.

Nuts and locknuts shall conform to IS: 1363 (Part 1 to 3) -2002 "Specification for Black Hexagon Bolts, Nuts and Lock Nuts (Diameter 6-39 mm) and Black Hexagon Screws "**Specification for Hexagon Bolts and Nuts (M-42 to M150)**".

Plain washers shall conform to IS: 2016 -1967 "Specification for Plain Washers and spring washers shall conform to IS: 3063 -1994 "Spring Washers for Bolts, Nuts & Screws".

01.13.06 Steel Tubes for non-structural use

Steel tubes for non-structural use shall conform to IS: 1239(Part-I) -2004 "Specification for Mild Steel Tubes, Tubular and Other Wrought Steel fittings, Part-I: Mild Steel Tubes".

Fittings for steel tubes used for non-structural purposes shall conform to IS: 1239 (Part-II) -1992 "Specification for Mild Steel Tubular and Other Wrought Steel Pipe Fittings".

01.13.07 Threaded fasteners

Bolts and nuts for fastening shall conform to IS: 1367 (Part 1)-2002 "Technical Supply Conditions for Threaded Fasteners".

01.13.08 Testing

Test certificates from manufacturer shall be submitted for each consignment. Any additional test which the Engineer may require shall be done according to IS : 1786-2008, 1566-1982, 280-2006, 2062-2006, 1161-1998, 2614-1969, 3063-1994, 1239 (Part 1-2004 and Part 2-1992) and 1367-2002.

01.13.09 Cast Steel

Quality

Cast steel shall conform to IS: 1030-1998 "Carbon Steel Casting for General Engineering Purpose". Unless otherwise specified, it shall conform to Grade2.

01.13.10 Conduits



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Steel for electrical wiring

Rigid steel conduits for electrical use shall conform to IS: 9537 (Part 2) - 1981 for rigid pipes and to IS: 3480-1966 for flexible conduits. Fittings for conduits shall conform to IS: 2667-1988.

All conduit pipes shall be finished with galvanized or stove-enameled surface. All accessories shall be of threaded type and pipes shall be jointed by means of screwed couplers only. Bend in conduits shall be made to the dimension shown in drawing, but a minimum of 12 times the diameter. Where shown in drawing they shall be treated with anticorrosive preservative as specified.

Non-metallic conduit for electrical wiring

Non-metallic conduits for electrical use shall conform to IS: 9537 (Part 3) -1983 for rigid pipes and to IS: 6946 -1973 for flexible pipes. Fittings shall conform to IS: 3419-1988.

Bends shall be achieved by bending the pipes by inserting suitable solid or inspection type normal bends, elbows or similar fittings.

01.14 Brick and stones

01.14.01 Bricks

Bricks for masonry in foundations, walls and other locations shall be common burnt clay building bricks having minimum crushing strength of 5 N/sq.mm., or such other strength as may be described in the Schedule of Items, when tested in accordance with IS : 1077-1992 "Common Burnt Clay Building Bricks". They shall be sound, hard and thoroughly well burnt, with uniform size having rectangular faces with parallel sides and sharp straight right angled edges and be of uniform colour with fine compact uniform texture. Bricks shall be of uniform deep red cherry or copper colour. They shall be free from flaws, cracks and nodules of free lime. Water absorption after 24 hours immersion in cold water shall be not more than 20% by weight. They shall not absorb more than 10% by weight of water after immersion for six hours. They shall emit a clear metallic ringing sound when struck by a mallet and shall not break when dropped on their face, from a height of 60 cm. Fractured surface shall show homogeneous, fine grained uniform texture, free from cracks, air holes, laminations, grits, lumps of lime, efflorescence or any other defect which may impair their strength, durability, appearance and usefulness for the purpose intended. Under burnt or vitrified bricks shall not be used. Samples of bricks brought to the site shall be tested periodically for compression and other tests according to IS: 3495 (Parts-1 to 4) - 1992 "Method of Test for Burnt Clay Building Bricks". Where the size of bricks is not specifically mentioned, it shall be taken to mean conventional sizes as is commonly available in the area. In case modular bricks are to be used, it shall be accordingly specified in Schedule of Items. The bricks shall be classified on the basis of average compressive strength as given in table 1 of IS: 1077-1992.

01.14.02 Handling

Bricks shall be unloaded by hand and carefully stacked and all broken bricks shall be removed from the site.



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01.14.03 Samples and Inspection

Representative Samples shall be submitted by the contractor and approved samples retained by the Engineer for comparison and future reference. Bricks shall be obtained from approved manufacturer. All bricks shall be subject to inspection on the site and shall be to the approval of the Engineer who may reject such consignment as are considered by him to be inferior to the quality specified. The Contractor shall provide all labour and plant required for the inspection and conduct such test as shall be required by the Engineer without additional charges.

01.14.04 Brick Bats

Brick bats shall be obtained from well burnt bricks of approved quality.

01.14.05 Laterite Stone Blocks

These shall conform to IS: 3620 -1979 "Laterite Stone Blocks for Masonry". The laterite stone blocks shall have a minimum compressive strength of 30 kg/cm² and to be tested as per IS: 1121-1974. The blocks shall be minimum 15 cm thick but not exceeding 30 cm. They shall be dressed to the desired sizes and shapes with an axe. Laterite stones shall be well seasoned by exposure to air before dressing and using on work.

01.15 Fly ash-Cement Bricks

01.15.01 Scope

This section covers the setting up of a manufacturing plant for fly ash – cement bricks as per the directions of the Owner. This section also includes transportation of raw materials storage and proportioning of raw materials, handling and mixing of raw materials, manufacturing of bricks, curing, handling and laying of bricks and conducting quality control tests.

Unless specifically mentioned otherwise, all applicable codes and standards published by the Bureau of Indian Standards shall govern design, workmanship, quality and properties of materials, method of field and laboratory testing, method of measurement for different items of work etc.

01.15.02 Materials

01.15.02.01 Cement: 33 grade ordinary Portland cement conforming to IS: 269 or Higher Grade above 33 Grade.

01.15.02.02 Sand: Sand shall be free from deleterious materials like clay and silt in sand and shall be less than 5%. Sand shall conform to IS: 383.

01.15.02.03

01.15.02.04

01.15.02.05 First Aid Treatment

Necessary first aid treatment shall be made available at site by the contractor.

01.15.02.06 Storage of Raw Materials



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01.15.02.07 Cement

The cement used shall be as specified in Clause No. 1.3.1. The contractor shall carry out the required tests at his own cost in an approved testing laboratory and submit the test report for the approval of the Engineer before using the cement in the works. Cement shall be stored on raised platforms inside stores covered on all sides and roof with provision for ample ventilation. More than ten (10) bags of cement shall not be stacked one above the other in the stack. Sufficient space shall be left around the stacks for approach. Stacking shall be so arranged that bags from the oldest consignment can be conveniently removed first for use following the principle of first in first out (FIFO) basis. For the proper label tag indicating date of supply shall be displayed over the stack of stored cement received that a consignment (Batch) cement which has hardened, clodded or deteriorated due to over stacking or long storage shall not be used in the works and shall be removed from the site immediately with instruction to Employer and Engineer-in-charge.

01.15.02.08 Void

01.15.02.09 Sand (Fine aggregate)

Sand shall conform to IS: 383 and shall be river or pit sand. Sand shall be spread at site on clean and hard base or in compartments. Samples of sand to be used shall be submitted to the Engineer-in-charge for approval before commencement of work. The contractor shall ensure that over the entire period of construction all consignments of sand brought to the site conforms to the quality and grading as approved by the Engineer-in-charge before the commencement of work. Whenever directed by the Engineer-in-charge the contractor shall perform tests at his own cost to satisfy that the grading and quality approved for sand is being maintained. Sampling of aggregate shall conform to IS: 2430 and tests shall conform to IS: 2386. The percentage to flaky and elongated pieces should not exceed 15%.

01.15.03 Void

01.15.04 Void

01.15.05 Void

01.15.06 Void

01.15.07 Mixing

The raw materials shall be weigh batched and uniformly and properly blended in pan mixer for about 3 to 5 minutes with required quantity of water. If the mixture contains lumps, the mixing time shall be increased.

01.15.08 Void

01.15.09 Marking

All pre-cast bricks shall be marked in a manner approved by the Engineer-in-charge in a conspicuous place with date of manufacture and marking number. The upper part of the bricks shall be marked distinctly to ensure proper handling.



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01.15.10 Curing

The contractor shall keep all the bricks wet for not less than 28 days.

01.15.11 Testing & Acceptance criteria

01.15.12 Sampling and criteria for conformity

Sampling and criteria for conformity of the bricks shall be as given in IS: 5454.

01.15.13 Void

01.15.14 Drying shrinkage

The average drying shrinkage of three units shall not exceed 0.15% when tested by the method described in IS:4139.

01.15.15 Efflorescence

The bricks shall be tested as per IS:3495 (Part-3) and shall have the rating of efflorescence not more than moderate.

01.15.16 Water absorption

The bricks, when tested in accordance with the procedure laid down in IS:3495 (Part-2) after immersion in cold water for 24 hours, shall have average water absorption not more than 20% by mass.

01.15.17 Laboratory

The rate of raw materials and quality of bricks shall be tested in the presence of Engineer-in-charge in the approved laboratory with above testing facilities.

01.16 Void

01.17 Void

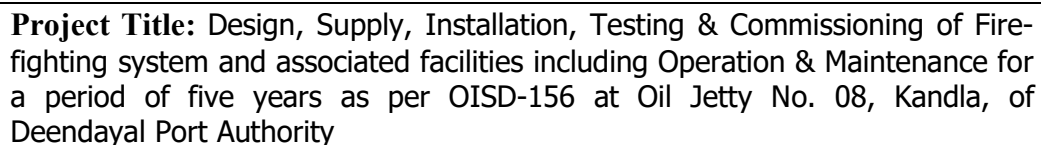
01.18 Cement, lime and water

Cement, lime and water shall conform to the specification under the Section Concrete of this part.

01.19 Sand for masonry mortar

Sand for masonry mortars shall be natural sand, crushed stone sand or crushed gravel and shall comply with IS: 2116 - 1980 "Sand for Masonry Mortars". The sand shall be hard, durable, clean and free from adherent coatings and shall not contain amount of clay, silt and fine dust more than 5% by wt. Sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal, mica and organic matters. The particle size grading of sand for use in mortars shall be within the limits as specified in Table I of above code.

01.20 Sand for plastering



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Sand for use in mortars for internal wall, ceiling and external plastering and rendering shall conform to IS: 1542 -1992. It shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal, mica and organic matters. Percentage of salt and dust shall not be more than 5% by weight. Grading of sand shall be within the limits specified in clause no. 5.1 of above code. Fineness modulus of naturally occurring sand shall not be less than 1.5.

01.21 Soling Stones

Material for soling shall be natural stone boulders or crushed blast furnace slab. Stones for soling shall be of height equal to thickness of the soling with tolerance of plus or minus 25mm and shall not have a base area of less than 250 sq.cm. nor more than 500 sq.cm. and the smallest dimension of any stone shall not be less than half the largest dimension. Stones shall be tough, angular, durable and generally free from flat, elongated, soft and disintegrated particles. They shall also be free from dirt or other objectionable matter and be obtained from quarries approved by the Engineer.

Crushed slag obtained from air-cooled blast furnaces slag shall be angular, of reasonably uniform quality and density and generally be free from any thin, elongated, and soft pieces, dirt or other objectionable matter. The density of slag should not be less than 1.12 gm/cc and glassy material shall not exceed 20%. Water absorption when determined in accordance with IS: 2386 (Part-III) - 1963. "Methods of Tests for Aggregates for Concrete: Specific Gravity, Density Voids, Absorption and Bulking", shall not exceed 10%.

01.22 List of materials of approved brand and/or manufacture

Unless otherwise specifically mentioned in the Schedule of Items, Contractor has to use materials as listed below, of only these brand names/Company's names, which are mentioned in the approved list for civil, water supply and sanitary items thereon.

A. Building materials

15. CONSTRUCTION CHEMICALS

Choksey, CICO, SIKA, FOSROC,
DR.FIXIT, BASF

01.23 Materials not specified

Any materials not fully specified in these specification and which may be offered for use in the works shall be subject to approval of Engineer, without which it shall not be used anywhere in the construction works.



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SPECIFICATION FOR CIVIL WORKS

PART – II WORKMANSHIP

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GENERAL

1.1 Standard

A high standard of workmanship in all trades will be required. The Contractor shall ensure that only skilled and experienced workmen are employed.

1.2 Supervision

The Contractor's supervising staff shall be fully qualified and experienced in the types of work being carried out under their supervision and shall be capable of ensuring that work is executed efficiently and as per specification.

1.3 Temporary works

Where required, the Contractor shall furnish such details of his temporary works as may be called for by the Engineer and the Contractor shall satisfy the Engineer as to their safety and efficiency. The Engineer may direct that temporary works, which he considers unsafe or insufficient, shall be removed and replaced in a satisfactory manner.

1.4.0 Codes

1.4.1 The years of publication against various standards, referred in this specification, correspond to the latest standards as on date of preparation of this specification. During use of this specification in future, the latest publication as on date shall be referred to. Where



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standards are not yet published by the BIS or IRC, adoptable British Standards or other International Standards shall apply.

In case of any conflict in meaning between these specifications and those of BIS or IRC, or British/International Standards, the provisions of these specifications shall prevail.

1.5 Base lines and bench marks

The Contractor shall establish and maintain, to the satisfaction of Engineer, the base lines and bench marks, based on which the works are set out. Where such base lines and bench marks are provided by the Engineer, the Contractor shall maintain these throughout the period of construction without causing any disturbance to them.

1.6 Setting out

The Contractor shall set out all the works to be executed by him, in line with the standard base lines, levels, position and bench marks and truly as per drawings within the accepted tolerance limits at no extra cost to Owner. The Contractor shall be solely responsible for the setting out of all the works, to be executed by him and the approval of such setting out by the Engineer shall in no way absolve the Contractor his responsibility for carrying the work to the true lines, levels and positions as per drawings.

1.7 Dewatering

The Contractor shall carry out all the works, in dry and workable condition and maintain the same in dry condition till the final handing over of works at no extra cost to the Owner. For this the Contractor shall make all the necessary provisions of dewatering, wherever necessary, to the entire satisfaction of the Engineer.

1.8 Safety of existing work

Before taking up any construction adjoining other property or existing work, the Contractor shall take all steps necessary for the safety and protection of such property or work at no extra cost to the owner.

1.9 Protection of existing services

The Contractor shall take all precautions necessary to prevent damage to or interference with underground or over ground services such as cables, drains, piping or piles, whether shown on drawings or not. Equipment etc., mounted in position shall be protected against falling debris etc., by means of tarpaulin or such other material at no extra cost to the owner.

1.10 Handing over of work site

On completion of work, the Contractor shall remove all rubbish, debris, surplus materials, temporary work etc., from the site. The site shall be handed over in a tidy and workmanlike manner at no extra cost to the owner.

2.0 EARTH WORK

2.1 Scope



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This chapter deals with earth work and excavation for civil works in site, formation/oversite leveling, foundations, cutting and grading for roads/pavement and railways, canals, embankments other than water retaining embankments trenching for drainage and other buried services and the like.

2.2 General

The Contractor shall carry out the excavation strictly to the lines and levels, in conformity with the drawings or instructions of the Engineer.

2.3 Setting out

Before commencement of earthwork block levels of existing ground shall be taken by the Contractor jointly with the Engineer, plotted and signed in token of acceptance of ground levels. Excavation shall not be commenced until the initial ground levels have been recorded and accepted. Reference lines, bench marks and base lines shall be set out by the Contractor for control of earthwork operation. Setting out shall be done with pegs, blocks, bamboo poles or rails, marking boundaries or centre lines, as the case may be, and the same maintained for reference and future checking. Chainage stones at regular intervals shall be set up for embankments. All setting out operations shall be got checked and approved by Engineer. However, such checking and approval by the Engineer shall in no way absolve the Contractor of his responsibilities for carrying out the work to the true lines, levels and positions as per drawing, and in case any error is noticed at any stage in the contractor's work, it shall be corrected/rectified by him without any cost to the Owner.

2.4 Site clearance and demolition

The site shall be cleared of all trees, stumps, roots, brush wood, bushes and other objectionable materials. Useful and saleable material, if any, shall be the property of the owner and shall be stacked properly as directed by the Engineer. The areas to be covered with embankments shall be stripped of top soil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Top soil which is suitable for use in construction work shall be stockpiled for later use. Other objectionable materials such as trash, debris, stones, brick, broken concrete, scrap metal etc., shall be disposed off as directed by the Engineer. Payment for cutting and removal of trees, stumps, dismantling existing structures and stripping shall be regulated by the description in the Schedule of Items or Part V of these specifications.

2.5 Classification of soil

The Engineer will decide the class of any particular soil. Classification of soil shall be as under and the decision of the Engineer shall be binding on the Contractor :



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A) Ordinary soil

Soils which yield to ordinary application of pick and shovel, phawra rake or other ordinary digging implements (including earth moving equipment such as bulldozer, shovels without resorting to blasting) without offering much resistance, shall be classified as ordinary soil. This includes organic soil, turf, sand, gravel, loam clay, mud, peat, black cotton soil, soft shale and loose moorum etc.

B) Hard soil

This comprises of all soils that cannot reasonably be excavated by the above mentioned digging implements, but can be excavated with close application of pick axe or scarifiers or jumpers to loosen. This includes compact moorum, stiff clay, hard shale, cobble stone etc.,

C) Soft /decomposed rock

This comprises of rock or boulders which may be quarried or split with crow bars, pavement breakers etc., This include lime stone, sand stone, weathered rocks and hard conglomerates etc .and existing structures embedded in earth and tarred macadam roads, pavements, met in the excavation. The fact that contractor resorts to blasting for his own reasons shall not mean that the rock is hard and classified as hard rock.

D) Hard rock

This comprises of rocks which require blasting for excavation. Where blasting is prohibited, excavation has to be carried out by chiseling, wedging or any other agreed methods.

2.6 Method of excavation

The Contractor may carry out excavations, filling and compaction by any method considered most suitable, and befitting the site conditions subject to any stipulations contained in the contract and the specifications. All excavations shall be required to be kept completely free from water, from whatever source it may come, during the construction. No foundation work shall be taken up until the surfaces are properly drained. 2.7 Excavation of soils other than hard rock

Excavation shall be carried out in the most expeditious and efficient manner to the lines and levels as indicated in drawings or as directed by Engineer. Prior approval of the Engineer shall be taken for the method to be adopted for excavation including dimensions, side slopes, dewatering, shoring etc., Such approval shall not make the Engineer responsible for any consequent damage or loss caused. All precautions shall be taken to preserve the material below and beyond line of excavation in soundest condition. All damages done beyond limits of excavation shall be made good by the Contractor at his own cost in a manner approved by the Engineer. All excavated materials shall be removed to spoil heaps, dumping yards or transported for filling as may be necessary. When soil heaps are formed for future use, heaps shall be protected from washing away due to rain or surface run off. The sides of excavation shall be maintained in stable condition by adequate stepping and batter. To prevent entry of surface water and accumulation of subsoil water in excavated areas, suitable drainage arrangements as may be needed and directed by Engineer, shall be



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provided and maintained. Pumped out water shall be drained off properly avoiding damage to other existing works. If any pipelines, cables or service lines are likely to be exposed, excavation around these services shall be carried out manually and all such services shall be adequately supported and protected at no extra cost.

Excavation shall be carried out in any material encountered including road surfaces, pavements, buried parts of old foundations, pits or other structures. Excavated materials shall be placed beyond 1.5 metres of the edge of the excavation pit/trench or half the depth of the pit/trench whichever is more or further away as directed by the Engineer. Sumps made for dewatering must be kept clear of the foundations. In firm soil the sides of the trenches shall be kept vertical upto a depth of 2.0m from the bottom and for a greater depth, trench shall be widened by allowing steps of 50cm on either side after every 2.0m depth from the bottom, so as to give a vertical side slope of 1/4 : 1. Where the soil is soft, loose or slushy, the width of the steps shall be suitably increased or sides suitably sloped or suitable shoring and strutting provided as directed by the Engineer. For trenches deeper than 2.0m, the Contractor shall obtain detailed instruction from the Engineer in writing regarding the stepping, sloping of sides or shoring and strutting to be done. For these bye-works, no extra cost will be paid to the Contractor.

2.8 Excavation in hard rock

Where hard rock is met and blasting is considered necessary for its excavation, the Contractor shall intimate the Engineer in writing. Excavation in hard rock shall be done either by blasting or chiseling or by such other agreed methods as may be required. Levels of hard rock surface shall be taken and got approved by Engineer before start of excavation. Blasting shall be permitted only when proper precautions are taken for protection of persons, works and property. The Contractor shall obtain the necessary licence for procuring, storing and using explosives.

Blasting operations shall be carried out by a licensed Blaster. The quality and quantity of explosives, size and spacing of holes depth of holes etc., shall be such that they will neither open seams nor damage or shatter the rock beyond the specified lines of excavation. A tolerance of 150 mm will however be allowed beyond the excavation lines. As excavation approaches final stages, the depth of holes and the amount of explosives used shall be reduced progressively to avoid over breakage or damage to founding strata. Any fissures, cracks and voids below prescribed depth of excavation shall be corrected by removing loose pieces, shattered or affected rock and replaced by lean concrete of M-5 grade or (1:5:10) cement concrete in the case of foundations. Where excavated surface is to receive structural concrete, the surface shall be cleaned of dust and other objectionable materials.

In cases where blasting, though otherwise required, is prohibited because of any reason, the excavation shall be carried out by chiseling, wedging or such other agreed methods. All materials excavated from blasting, chiseling or any such methods shall be stacked for measurement as directed by Engineer.

2.9 Cutting and filling for site levelling



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Excavation and filling operations for site leveling shall be so planned and executed, that transportation and re-handling are minimised. The sides of excavation and fills shall be maintained in stable condition by adequate batters, stepping and dewatering. Materials not desirable shall be disposed off in area indicated by Engineer. When it is required to blend the material, it shall be done by selective excavation and filling operation. Wells, ponds, cesspools and water logged areas shall be emptied of water and deslushed before filling. Filling shall be done in horizontal layers not exceeding 300mm in thickness as specified or as directed by the Engineer. All clods shall be broken before placing the fill. Earth moving equipment shall be allowed to ply over the fill to permit compaction. Adequate allowance shall be made for subsidence of fill material. Levels shall be taken and excess or shortfall shall be made good by appropriate cutting or filling.

2.10 Excavation for trenches

Excavation for trenches shall be carried out in materials encountered to enable laying of service lines or drainage channels or any other desired purpose. Excavation shall be done to lines and levels shown in drawings and shall be done providing adequate measures for stability. Vertical wooden sleepers or light rails shall be erected at uniform levels at places where changes of direction and gradients occur. Centre lines shall be marked on horizontal sleepers or rails, laid across the trenches. Depths of excavation and pipe invert levels shall be checked by means of boning rods of appropriate lengths. Trench beds shall be trimmed and rammed with sprinkling of sand or moorum to required gradients for continuously supporting the pipelines. Trenches shall be locally deepened and widened to receive sockets and permit joints to be inspected.

Timbering

In case of trenches, tunnels, channels, drains, manholes, chambers, basement and other places where the soil is not capable of being retained without the support, timbering as directed by the Engineer shall be resorted to. It shall be the responsibility of the Contractor to take all the necessary steps to prevent the sides from collapsing.

2.11 Excavations for foundations

Excavation for foundation shall be done to the lines and levels indicated in the drawings. Excavated material shall be transported and stored at convenient spots for reuse in back filling of foundations and other fills. Surplus material shall be transported, spread and levelled at dumping areas. Side slopes of excavation and/or shoring shall be adequate from consideration of stability and working space. When so required and authorised by Engineer, the sides of excavation shall be protected with proper shoring, strutting, sheeting and sand bags etc., These shall be removed only when work in the pit is completed, with the approval of the Engineer. When it is felt that removal of supports may result in side collapse or settlement of adjoining ground or endanger adjoining structures and foundations, they shall be left permanently in position. The last 150 mm of excavation shall be done and the bottom trimmed to the required levels only when concreting is imminent. If at any point the natural ground is disturbed or loosened for any reason, it shall be consolidated by tamping or



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rolling or made up with concrete of M-5 grade, or (1:5:10) cement concrete if so ordered by the Engineer at no extra cost. Where the soil encountered at depths indicated in drawings is loose or weak, it shall be further excavated to levels of firm strata as may be directed by the Engineer and filled with lean concrete of M-5 grade/(1:5:10) cement concrete or sand as directed. If the bottom of excavation has been left exposed not through neglect or fault of the Contractor and it has become deleteriously affected by atmospheric action and water, such portion of deteriorated foundation material shall be removed and made good by lean concrete of grade M-5/(1:5:10) cement concrete or sand as directed and such extras will be paid for.

2.11.1 For deep excavation in the proximity of existing buildings, foundations, streets, railway tracks, underground cabling, gas piping, water and drainage lines, and the like, adequate appropriate precautions shall be taken to protect such structures or works from damage, displacement or settlement, either as an immediate result of the excavation or as after effect, discernible with the passage of time. The method of protection of existing structures and services may include sheet piling, shoring, strutting slinging or any other method including dewatering. Payment for such protective work shall be governed by the description given in the Schedule of Items for the particular work.

2.11.2 For excavation adjoining existing piles care shall be taken to ensure that no pile under any circumstances is exposed from the top for a height exceeding 2 metres. No strutting shall be done against exposed piles, nor exposed piles ever used for tying guy ropes or supports either temporarily or permanently.

2.12 Excess excavation

All excavation done beyond the specified limits or directions of Engineer shall be considered as excess excavation. They shall be made good as prescribed below by the Contractor at his cost:

- i) Excess excavation in case of site leveling shall be made good by filling and compacting with material same as the surrounding material. Degree of compaction shall be at least the same as the surrounding material.
- ii) Excess excavation in case of trenches shall be made good by filling and compacting with selected earth to the same compaction as the surrounding material or as directed by Engineer. This shall be done in layers not exceeding 150 mm thick, moistened and thoroughly compacted by tamping.
- iii) Excess excavation in case of foundation beyond required depths shall be made good by filling with lean concrete of M-5 grade/(1:5:10) cement concrete.

2.13 Disposal of excavated materials

Excavated materials that are unsuitable for use in construction works or in excess of construction requirements shall be disposed off in dumping yards or in locations indicated by Engineer. Waste piles/heaps shall be located in such places where they will not interfere with natural flow of rain water access or transport or with the access to nearby



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structures. When required, they shall be levelled and trimmed to such lines and levels as indicated by Engineer.

2.14 Back filling of trenches

Trenches shall be backfilled after pipes or service lines are tested and approved. Filling shall be done with earth in 150 mm thick layers free from unwanted material and well rammed. Soft material shall be used in bottom of trenches upto a level of 150 mm above the top of pipes before backfilling with other fill materials. All clods and lumps shall be broken before placement. Care shall be taken not to disturb, break or damage the pipes during backfilling and compaction process.

2.15 Backfilling of foundations

Backfilling of foundations shall be done using suitable soils from excavations. Soil shall be free from organic matter and other materials which would affect the stability of the fill and shall be free from boulders, brick bats wood pieces and other injurious materials, lumps and clods. Before commencement of backfilling of foundations. all shoring and formwork, bits of timber, cement bags and all other rubbish shall be removed. Hydro-insulation, Bitumen painting or application of anti-corrosive protective and anti-termite treatments shall have been completed. Backfilling operation shall not commence without approval of Engineer. Backfilling shall be carried out in well compacted layers of 150 mm thickness. Each layers shall have near optimum moisture content. Layers will extend to the entire width of excavation and shall be sprinkled with water during compaction process. Ramming shall be done to achieve firm compaction. Backfill shall be trimmed and finished to lines and levels indicated in the drawings and/or as directed by the Engineer. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

2.16 Filling under floors

Material for filling under floors shall be soil free from harmful minerals, vegetable matter etc., and shall not be expansive soils. Filling shall be done in well compacted layers not exceeding 150 mm in thickness. Each layer shall be compacted to 95% Standard Procter Density. Sufficient soaking shall be done before compaction. The entire area to be covered by flooring shall be finally dressed and trimmed to required levels. Mechanical equipment like vibratory roller, vibro earth rammer or vibratory compactor shall be used for compaction.

2.17 Load bearing fills

Load bearing fills include embankments for roads and railways and such other earth fills above ground levels provided for protection of fuel oil tanks, pads for storage tanks, drain, bunds and the like. Fill materials shall either be selected earth obtained from excavations for site leveling, trenches and foundations or from selected borrow areas as may be required. Soils selected for filling in embankments shall be of uniform quality and free from boulders, organic materials and other objectionable matter. Soils having high silt and clay content and having laboratory maximum dry density less than 1.44 gms per c.c. shall not be used for load bearing fills. For fills greater than 3 m in height soils shall have laboratory density



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not less than 1.52 gms per c.c. Soils for top 500 mm of fills for roads and railways shall have laboratory density not less than 1.65 gms per c.c. and shall not have marked swelling and shrinkage properties.

Foundation preparation for embankments shall be done as prescribed under site clearance. The founding strata shall be compacted as much as possible by rolling or tamping before placement of fill material. The water content of founding strata should be same as that specified for embankment fill. Any pockets of loose material or depressions left in founding strata as a result of clearing operation shall be filled and compacted with the same material as the surrounding founding strata. When an embankment is to be placed on steep sloping ground the surface of the ground shall be trenched in steps or trenched or broken up in such a manner that the new materials bonds well with the founding strata.

Fill material shall not be placed until foundation has been inspected and approved by Engineer. Material shall be placed in even, continuous, horizontal layers over full width of embankment in well compacted layers not exceeding 200 mm thickness. Each layer shall be compacted by means of smooth rubber tyred rollers, sheep-foot rollers, tractors, tampers or other mechanical means as may be found suitable for the location. Before rolling, the water content shall be checked and corrected by sprinkling with water or adding dry material or aeration as may be required. This shall be followed by mixing and the layer left for soaking before compaction. The water content shall be within plus or minus 2% of Standard Proctor Optimum. Density of compacted layers shall be determined by sand replacement method. Average compacted density shall be at least 95% of Standard Proctor Density. The number of tests to be conducted for determination of moisture content and density shall be as prescribed by the Engineer. Side slopes of embankments shall be formed along with the main embankment. No side dumping shall be done for the formation of slopes. When required the width of each layer shall be constructed slightly in excess of required width and slopes trimmed to remove loose edge materials and completed to lines shown in drawings or as directed by the Engineer. Subgrades for road works shall be thoroughly wetted sufficiently in advance of placing of any base course and it shall be ensured that it is firm and moist for at least 50 mm below the surface. Should the subgrade for any reason be loose or have density less than required, it shall be recompacted and refinished. Excessive loss of moisture in the subgrade shall be prevented by sprinkling and/or scaling. No traffic or hauling equipment shall be permitted to ply on finished subgrade and any damage caused to such portion shall be made good by the Contractor at his own cost.

3.0 Void

4.0 CONCRETE PLAIN & REINFORCED

4.1 Scope

This chapter covers the workmanship, special requirements & regulations with which the contractor must comply to achieve the following two objectives :

- (a) The provision, at all locations on the site, of dense workable concrete, having the specified characteristic strength.



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(b) The placing of concrete at all elevations, well compacted by vibrations, in well aligned and well fixed formwork ensuring the internal and external dimensions of structures as per drawings and maintaining the size, shape number and locations of reinforcements, inserts etc., as specified in the drawings providing the surface finish after stripping off the formwork to ensure the structural configurations as per drawings as well within the specified tolerance limits, curing and guaranteeing the characteristic strength, all as specified.

4.1.1 The mixing, placing, compacting, curing and finishing of concrete shall be done according to IS: 456-2000 "Code of Practice for Plain and Reinforced Concrete".

4.2 Materials

For materials, reference to Part - I (Materials) shall be made.

4.3 Grades of Concrete

The grades of concrete unless otherwise specified shall be in accordance with the following table. The grade of concrete to be used in each section of work will be shown in the drawings or in the schedule of items :

Grade of Concrete	Characteristic Strength i.e. Compressive Strength of 15 cm cubes at 25 days (N/mm ²)	Nominal Maximum Aggregate Size (mm)
M-5A	5	63
M-5B	5	40
M-7.5A	7.5	63
M-7.5B	7.5	40
M-10A	10	63
M-10B	10	40

M-10C	10	20
M-10D	10	12
M-15A	15	63
M-15B	15	40
M-15C	15	20
M-15D	15	12
M20A	20	63



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M-20B	20	40
M-20C	20	20
M-20D	20	12
M-25C	25	12
M-25D	25	12
M-30C	30	20
M-30D	30	12
M-35C	35	20
M-35D	35	12
M-40C	40	20
M-40D	40	12

Notes: A, B, C, D mentioned along with grade of concrete correspond to the maximum size of coarse aggregate being 63mm, 40mm, 20mm & 12mm respectively.

Unless otherwise specified in the drawings or schedule of items the maximum nominal size of coarse aggregates for different grades of concrete shall be as under :

	For concreting in very narrow space or in very small thickness	12 mm
	For all reinforced concrete work except in massive foundations	20 mm
	For all ordinary plain concrete & massive reinforced foundations	40 mm

4.4 Mix Design

4.4.1 General

At the commencement of the contract the Contractor shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suitable for the conditions of handling and placing and when concrete hardens, it shall have the required strength, durability and surface finish. The Contractor shall get approval of Engineer to such proportions before he starts concreting. However, such approval shall not relieve the Contractor of his responsibility to produce concrete having compressive strengths as laid down in the foregoing Table.



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No departure from the approved proportions will be permitted during the works unless and until the Engineer gives written authorisation for any change in proportion. The Engineer shall have authority at any time to check whether the mixing of concrete is being carried out according to the approved proportions.

4.4.2 For the all major and important R.C. works and for all special works, the design of mixes shall be made by the Contractor at his own cost, for each grade of concrete as well as for various workability. The design of mixes shall be made according to I.S. 10262-2009 or any other approved standard methods.

4.4.3 The concrete made by designing the mix is termed hereinafter as "Design Mix Concrete".

4.4.4 The cement content for various grades of concrete shall be based on design mix. However, irrespective of requirement of cement found out from design mix, minimum & maximum cement content of concrete shall be in accordance with Clause No 8.2.4.1 & Clause No 8.2.4.2 of IS 456-2000 respectively.

4.5 Water/Cement Ratio

4.5.1 Where a particular water/cement ratio is stipulated in the design or drawing along with the characteristic grade of concrete the design of mix shall be carried out by adjusting the other variable factors to obtain the characteristic strength of concrete with stipulated water/cement ratio.

4.5.2 In the structures where the impermeability and shrinkage of concrete have an important bearing on the durability and serviceability of the structures, such as water retaining structures, basements, underground premises, tunnels, pump houses, exposed structures near sea side or deserts, prestressed structure, thin pre-cast members etc. the water cement ratio shall be kept low and preferably not exceeding 0.45.

4.5.3 The water cement ratio, as achieved in the Mix Design, or as specified in the drawings shall be adhered to strictly and shall not be varied without the permission of the Engineer.

4.6 Workability

4.6.1 The workability of fresh concrete shall be such that the concrete is just suitable for the conditions of handling & placing so that after compaction it becomes completely consistent and homogeneously surrounds all the reinforcement and completely fills the formwork.

4.6.2 The workability of fresh concrete at the place of batching/mixing shall be measured by compacting factor test and at the place of disposition by means of slump test. During the finalisation of Trial Mixes, the relationship between compacting factor and slump test shall be established for each grade of concrete as well as for various levels of workability. The workability tests shall be carried out in accordance with IS:1199-1959.



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4.6.3 Normally, in the condition of low water cement ratio as well as for medium/high workability, the workability shall be achieved by increasing the cement content, in consistent with added water.

4.6.4 In cases where the cement content is to be limited to reduce the heat of hydration, and the water/cement ratio is also to be kept low to reduce the permeability or due to other requirements the desired workability may be achieved with use of limited doses of plasticiser or air entraining agent. In such cases the method of mixing and dosage of the plasticiser/air entraining agent shall be according to the manufacturer's specification and with the approval of the Engineer.

4.6.5 The usual limits of consistency for various types of structures are given below :

Limits of consistency Degree of workability	Slump in mm with standard - Cone		Use for which concrete is suitable as per IS:1199
	Minimum	Maximum	
Very low	0.0	25.0	Large mass concrete structure with heavy compaction equipment, roads and the like
Low	25.0	50.0	Un congested wide and shallow R.C.C structures
Medium	25.0	75.0	Deep but wide R.C.C structures with congestion of reinforcement and inserts
High	75.0	125.0	Very narrow and deep R.C.C structures with and inserts congestion due to reinforcement

Note : Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer. With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

4.7 Durability

The durability of concrete, depending on the exposure condition, is to be taken into account while designing the mix. For given aggregates, the cement content should be sufficient to make sufficiently low water cement ratio and Appendix A of IS: 456-2000 shall be taken as guideline for durability considerations.

4.8 Trial mixes

4.8.1 After approval of the Mix Design by the Engineer, the Contractor shall make in presence of Engineer the Trial Mixes for each grade of concrete as well as for required workability.



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4.8.2 Before starting the trial mixes, necessary preparatory works like sieve analysis of the aggregates, determination of densities of different ingredients and moisture contents in the aggregates, shall be completed according to the I.S. Codes 383- 1970 and 2386-1963.

4.8.3 Each trial mix shall be handled and compacted by the method which the Contractor proposes to use for that mix in the works and the mixes shall not show tendency of inadequate compaction by the method proposed.

4.8.4 The compacting factor and the slump of each trial mix shall be determined immediately after mixing and the values shall not exceed the maximum value obtained in the mix design.

4.8.5 Six numbers of 150 mm test cubes shall be made from each trial mix. These shall be cured and tested in accordance with relevant I.S. codes. In order to have the specified characteristic strength in the field, the concrete mix as designed in the Design Mix shall have higher average compressive strength depending on the degree of quality control at site. If the size and special requirement of the work so warrants, the trial may be extended to cover larger ranges of mix proportions as well as other variables such as alternative source of aggregates, maximum size and grading of aggregates and different type and brands of cement.

4.8.6 Before commencement of the concreting works of particular grade of concrete, the Contractor must complete the work of trial mixes and subsequent testing of the test cubes obtained therefrom the design of the Approved Mix for that particular grade of concrete.

4.8.7 The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the Contractor.

4.9 Nominal Mix Concrete

4.9.1 Nominal mix concrete may be used for all concrete of Grade M-10 and below. If design mix concrete cannot be used for any reason for Grade M-15 & M-20, nominal mix concrete may be used with the permission of Engineer, Nominal mix concrete shall not be used, in any case for Grade of concrete above M-20.

4.9.2 The proportioning of materials for nominal mix concrete shall be in accordance with Table-3 of clause 8.3 of I.S. 456-2000. The stipulations of Clauses 8.3.1 & 8.3.2 of IS: 456-2000 shall also be taken into consideration.

4.10 Void

4.11 Batching of Concrete

4.11.1 Cement

Cement shall always be batched by weight. A separate weighing device shall be provided for weighing cement. Where the weight of cement is determined by accepting the weight per bag, number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly

4.11.2 Aggregates



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4.11.3 For both Design Mix concrete and Nominal Mix concrete, the aggregates (coarse and fine) shall be batched by weight.

4.11.4 In particular cases, or where weigh-batching is not possible proportioning by volume batching may be allowed by the Engineer, provided the Contractor guarantees the uniformity of aggregates through out the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer. Where aggregates are moist and volume batching is adopted, allowance shall be made for bulking in accordance with I.S. 2386 (Part-III)-1963.

4.11.5 Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in their moisture contents.

4.12 Water

4.12.1 Water may be measured either by weight or by volume. When measured by volume, it shall be by well calibrated conical shaped jar or vessel or from a calibrated tank fitted to the mixer.

4.12.2 Adjustment of water due to moisture contents in coarse and fine aggregates

It is very important to maintain the water cement ratio constant at its correct value. For the correct determination of amount of water to be added in the concrete mix, to maintain the water cement ratio constant, the amount of moisture content in both coarse and fine aggregates shall be taken into consideration, be as frequently as possible, the frequency for a given job being determined by the Engineer according to weather conditions.

4.12.3 Determination of moisture content in the aggregates

Determination of moisture content in the aggregates shall be according to I.S. 2386 (Part-III)-1963. Where tests are not conducted, the amount of surface water may be estimated from the following table :

Aggregates	Surface water carried by Aggregates	
	% by weight	Lit / m ³
Very wet sand	7.5	120
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel & stone chips**	1.25 - 2.5	20-40

** - Coarser the aggregate, less the water it will carry.



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4.12.4 Admixtures

Any solid admixture, to be added, shall be measured by weight, but liquid or semi- liquid admixture may be measured by weight or volume.

4.12.5 Accuracy of batching

The accuracy of batching shall be within the following tolerance:

Cement within plus or minus 2% by weight.

Aggregate within plus or minus 5% by weight.

Water within plus or minus 0.5% by weight.

4.13 Mixing & Transportation of concrete

4.13.1 Mixing of Concrete

4.13.1.1 Machine mixing

Concrete shall always be mixed in mechanical mixer. Water shall not, normally, be charged into the drum of the mixer until all other ingredients are already in the drum and mixed for at least one minute. Mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and consistency. The mixing time from the time of adding water shall be in accordance with IS: 1791-1985 but in no case less than 2 minutes or at least 40 revolutions.

4.13.1.2 Hand mixing

When hand mixing is permitted by the Engineer it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. In case of hand mixing 10% extra cement shall be added to each batch at no extra cost to the Owner.

4.13.2 Transportation of concrete

4.13.2.1 Concrete shall be transported from the place of mixing to the place of placing concrete as rapidly as practicable by such means which will prevent the segregation or loss of any of the ingredients and maintain the required workability. No water shall be mixed with the concrete after it has left the mixer.

4.13.2.2 Where concrete is transported over long distances, the Contractor shall provide suitable means by which different grades of concrete are readily identifiable at the place of final deposit.

4.13.3 Actions before placement of concrete

4.13.3.1 Programme of works

At the beginning of every fortnight, the contractor shall give his detailed concreting programme for that fortnight to the Engineer. Such programmes, shall specify all information



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such as the locations where concrete is to be poured, type/grade of concrete, volume of concrete to be poured, number and Type of vibrators proposed to be used as well as proposed to keep as standby, number of skilled technicians and supervisors proposed to be engaged, the proposed time and period of pouring etc.

4.13.3.2 Checking & approval

Before placement of concrete, the contractor shall get all the form works, reinforcements, inserts, conduits, openings, surface preparation etc., checked and approved by the Engineer. To facilitate such checking, the contractor shall complete all his works according to the drawings and specifications well in advance before placement of concrete at least 36 hours for all major/important/complicated works and 24 hours for all minor/ordinary/simple works. The checks are purely in the interest of the work and to draw the contractor's attention to his contractual obligations to execute the works according to the drawings/specification and do not relieve the contractor from his responsibility in getting the end results for the quality & strength of concrete and for maintaining the shape, level & dimensions of the finished concrete, as well as the inserts, openings, other features within the tolerance limits.

4.14 Preparatory Works/Surface Preparation

4.14.1 For concrete directly on earth foundation

4.14.1.1 Earth foundation on which direct placement of concrete is specified, shall be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed with concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated, if necessary, a thin top layer of the wet soil shall be removed and replaced by sand or other suitable materials as directed by the Engineer without any extra cost to the Owner. Care shall also be taken that earth from the sides also does not get mixed with the concrete, during or after placement, before it has sufficiently set and hardened.

4.14.1.2 The earth foundation, over which concrete is to be placed direct, shall not be kept abandoned at the specified level and concrete shall be placed immediately following the final preparation of the formation otherwise suitable measures shall be taken, as directed by the Engineer without any extra cost to the Owner.

4.14.2 For construction joints

All such joints shall have continuous square bond grooves to produce a substantial and water-tight key. Where the placement of concrete has to be resumed on a surface which has hardened, it shall be roughened, cleaned by wire or bristle brushing, compressed air, water jet etc., and thoroughly wetted. For vertical construction joints a neat cement slurry shall be applied on the surface immediate before the placement of concrete. For horizontal joints the surface shall be covered with a layer of freshly mixed mortar about 10 to 15 mm thick composed of cement and sand in the same proportion as the cement and sand in the concrete mix and applied immediately before placing of the concrete. On this surface (i.e. on the surface of joints) a 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



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spots. To ensure water tightness, care shall be taken to punn concrete properly against the old surface.

4.14.3 (a) On vertical surfaces of masonry

When the concrete is placed on the vertical surface of masonry (as in the case of thin concrete fins projected from the vertical masonry surface), a groove of dimension as directed by the Engineer shall be cut in the masonry to ensure a proper bond and the surface shall be cleaned thoroughly. Before the placement of concrete, the surface shall be kept moist by spraying water at least for the period of 2 hours and a thick coat of cement slurry shall be applied immediately before the placement of concrete.

b) Over walls

Building paper over average 12mm thick cement sand bearing plaster of 1:4 mix with neat cement finish shall be provided at the bearings of slabs over walls as directed by the Engineer.

4.14.4 Inside the formwork (cleaning, surface preparation etc.,)

The interior of the form works, where the concrete is to be placed, shall be thoroughly washed by high pressure water jet or air jet to completely clean the entire volume from all sort of dirts, grease/oil, foreign and deleterious materials etc. The reinforcement shall be completely clean and free from all sorts of dirts, grease/oil, rust, foreign/deleterious materials etc., Before placement of concrete, the form works coming in contact with concrete, shall be coated with form oil or raw linseed oil material or provided with any approved material to prevent adhesion of concrete to the form work, but utmost care shall be taken so that such oily material do not come in contact with the reinforcement.

4.15 Placing and Compaction of Concrete

4.15.1 The concrete shall be placed and compacted before setting commences & should not be subsequently disturbed. No water shall be mixed with the concrete after it has left the mixer. Method of placing should be such as to preclude segregation. Approved mechanical vibrator shall be used for compacting concrete, and concrete shall not be over vibrated or under vibrated. No concrete shall be placed until the place of deposit has been thoroughly inspected and approved by the Engineer. all inserts and embedments properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer.

4.15.2 Concrete shall be placed on clean bed having the designed level. The bed shall be cleaned of all debris and other objectionable materials. Seepage water, if any, shall be controlled or diverted.

4.15.3 Concreting shall not be carried on during rains unless all precautions have been taken by the Contractor and necessary permission has been given by the Engineer. Suitable measures shall be taken to control the temperature of concrete.



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4.15.4 Where plums are permitted in massive concrete, they shall be washed and carefully placed. No stone shall be closer than 30 cm to an exposed face, nor nearer than 15 cm to an adjacent stone.

4.15.5 Concrete shall not be dropped from a height of more than 2m except through a chute, the design and type of which shall be subject to approval of the Engineer.

4.15.6 The concrete shall be placed, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas.

4.15.7 For members involving vertical placing of concrete (eg. columns, walls etc.), each lift shall be deposited in horizontal layer extending the full width between shuttering and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction.

4.15.8 For member involving horizontal placing of concrete (e.g. slabs, beams etc.) the concrete shall be placed along the line of starting point in such quantities as will allow members to be cast to their full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front parallel to the starting line. Vibration and surface finish shall follow behind the placement as closely as possible.

4.15.9 Utmost care shall be taken to avoid the displacement of reinforcements/embedded parts or movement of formwork or damage to faces of the form work or transmission of any harmful vibration/shocks to the concrete which has not yet hardened sufficiently.

4.15.10 All members shall be concreted at such a rate that no cold joint is formed and fresh concrete is placed always against green concrete which is still plastic and workable.

4.15.11 Should any unforeseen occurrence results in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the Contractor shall make at his own cost, suitable tongue, and groove construction joint, as approved by the Engineer. Any additional reinforcement required as directed by the Engineer shall also be provided by the Contractor at his own cost. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification stipulated earlier, shall be done by the Contractor at his own cost.

4.15.12 The concrete shall be worked well up against whatever surface it adjoins and compacted to such a degree that it reaches its maximum density as a homogeneous mass, free from air and water holes and penetrates to all corners of moulds and shuttering and completely surrounds the reinforcement. All measures shall be taken to make the shape, size, and location of the finished concrete including its embedments, holes, openings etc., well within the accepted tolerance limit.

4.16 Construction Joint & Cold Joints

4.16.1 Construction joints

4.16.1.1 Normally, the construction joints including crank inducing joints shall be constructed as per locations and details indicated on the drawings.



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4.16.1.2 Where the location of the joint is not specified in the drawings, it shall be in accordance with the following guide lines:

(a) In Columns

- (i) In case of Projection from basement slab, 300 mm from the top of base slab or 75 mm from the top of the haunches whichever is higher.
- (ii) In framing of beam at different elevation, 75 mm below the lowest soffit of the beam and in case of projection from beams and slabs 75 mm from the top surface of the beam/slab or at the top surface of beam/Slab whichever facilitates formwork.
- (iii) For columns under flat slabs 75 mm below the lowest soffit of the slab.

(b) In walls (horizontal construction joints)

- (i) Walls projecting from base slab : 300 mm from top of base slab
- (ii) Walls supporting the suspended slab : 75mm from the lowest soffit of the slab

Note : In the case of water retaining structures and structures under the influence of ground water, approved water bars of suitable size shall be provided to make the joint completely water-tight.

(c) In beams

Beams shall be cast, as a rule, without a joint. But if provision of a joint is unavoidable, the joint for simply supported beam shall be vertical and at the middle of the span ; in continuous beam, the same shall be at the point of minimum shear force.

(d) In suspended slabs

- (i) In slab of small span, there shall be no construction joints.
- (ii) In slabs of large span and continuous slabs, construction joint, if allowed by the Engineer shall be vertical at the middle of span and at the right angles to the principal reinforcement.

(e) In walls (Vertical construction joint)

As a rule, walls shall be cast monolithically without any vertical construction joint, unless specified in the drawing. However, for a long wall, the Engineer may allow vertical construction joint and the same shall be at the place of minimum shear force. In water retaining structures and in structures under the influence of ground water approved water bars of suitable size shall be provided to make the joints completely water tight.

(f) In slabs resting on ground

- (i) For Plain concrete



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Concreting shall be done in alternate panels not exceeding 10 sq.m in area. The largest panel dimension shall be 5 m.

(ii) For nominally reinforced slab

The area of pour shall not exceed 40 sq.m and the maximum panel dimension shall not exceed 8m.

For the basement slabs which act as structural member there shall be no construction joint.

(g) In ribbed beam

The beams shall be cast monolithically with the slab in one continuous operation.

4.16.1.3 In all construction joints the reinforcements shall pass through as per drawings and the same shall not be disturbed in any way.

4.16.1.4 The vertical construction joints shall be provided by insertion of board keeping provision for passage of reinforcement/fixtures / embedments. All construction joints shall be made to form a tongue and groove joint.

4.16.2 Cold joint

An advancing face of a concrete pour, which could not be covered before expiry of initial setting time for unexpected reasons, is called a cold joint. The Contractor shall remain always vigilant to avoid cold joints. If however, a cold joint is formed due to unavoidable reasons, the following procedures shall be adopted for treating it :

(a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly over the old surface and the fresh concrete along with the old concrete shall be vibrated systematically and thoroughly.

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

(c) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise in spite of extensive vibration, a tongue and groove joint shall be made by removing some of the older concrete and the joint shall be left to harden at least for 12-24 hours. It will then be treated as regular construction joint and the surface preparation of the same, before placement of concrete, shall be as described in the appropriate clauses of these specifications.

4.17 Requirements for Concreting in Special Cases



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4.17.1 Concreting in deep lifts Placing of concrete in lifts exceeding 2 M in columns and walls is in the category of deep lifts.

4.17.1.1 Before commencement of work, the contractor shall submit for the approval of the Engineer, the details of the methods he proposes to adopt for concreting.

4.17.1.2 The placement of concrete shall preferably be by tremie, chute or any other approved method.

4.17.1.3 In structures of heavy/complicated reinforcement or in complicated form works, the contractor shall provide sufficient number of windows in the form works as directed by the Engineer to check the placement and compaction of concrete in different stages. Such windows shall be closed as soon as the concreting reaches the bottom level of the same.

4.17.2 Concreting under water

When it is necessary to deposit concrete under water, the special requirements, over and above those of this specification shall be in accordance with Clause 13.2 of IS: 456-2000.

4.17.3 Cold weather concreting

When conditions are such that the ambient temperature may be expected to be 4.5 C degree or below during the placing and curing period, the work shall conform to IS: 7861 (Part-II)-1981.

4.17.4 Hot weather concreting

When concreting in very hot weather the Contractor shall take all precautions as stipulated in IS: 7861 (Part-I)-1975 and stagger the work to cooler parts of the day to ensure that the temperature of wet concrete used, specially in massive structure, does not exceed 38 degree 'C'.

Positive temperature control by methods like pre-cooling, post cooling or cooling of concrete by circulating cold water through small embedded pipe lines inside concrete, if required, shall be specified and shall be undertaken.

4.18 Finishes to Exposed Surfaces of Concrete

The Contractor is to include in his quoted rate for concrete, the provision of normal finishes in both formed & unformed surfaces as and where required by the Engineer without any extra cost to the owner. Some common finishes are indicated below:

4.18.1 Surface which do not require plastering

Surface in contact with casings shall be brought to a fair and even surface by working the concrete smooth against casings with a steel trowel while it is being deposited and also by working over the surface with a trowel immediately after the removal of the casings or centerings, removing any irregularities and stopping air holes, etc. Use of mortar plaster is not permissible for correcting levels, removing unevenness etc. However, if, in the opinion of the Engineer, such plastering is unavoidable then the thickness of plaster shall in no case exceeds 5 mm and the plastering shall be in cement and sand mortar.(1:3).



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4.18.2 Exposed surfaces which need plastering

Surfaces of beams/columns flushing with the block work or other structures where intended to plaster, shall be hacked adequately as soon as the shuttering is stripped off so that proper bond with the plaster can develop.

4.18.3 Surface for non-integral finish

Where a non-integral finish such as floor finish is specified or required, the surface of the concrete shall be struck off at the specified levels and finished rough.

4.18.4 For monolithic finish

Where no more finishing course is to be applied as in the case of basement floor, industrial flooring or the screed concrete flooring etc, the concrete shall be completed and struck off at the specified levels and sloped with a screed, board and then floated with a wooden float. Steel troweling is then started after the concrete has hardened enough to prevent the excess of fines and water to rise to the surface but not hard enough to prevent proper finishing. Troweling shall be such that the surface is flat, smooth and neatly finished.

4.19 Curing of Concrete

4.19.1 General

The purpose of curing is to prevent loss of moisture from the concrete itself so that the cement inside the concrete is sufficiently hydrated which of course is slow and prolonged process. As soon as the concrete has hardened sufficiently the curing shall be started. To cure the concrete properly and sufficiently is also the sole responsibility of the contractor.

4.19.2 Different methods of curing

Any one of the following methods may be used for curing as approved by the Engineer.

- (a) Curing by direct water.
- (b) Curing by covering the concrete with absorbent material and kept damp.

4.19.3 Curing by direct water

This is done either by ponding or spraying water.

(a) Ponding Ponding is widely used for curing slab and pavements. Earth bunds are formed over the slabs and water is pumped or poured into them and the same is replenished at interval to make up for the loss of evaporation. As this type of curing is one of the best methods, 10 days of curing after final setting is sufficient.

(b) By spraying water

Curing is done by spraying water by suitable means at approved time intervals. While spraying, it shall be ensured that the complete area is covered. In order to avoid cracking, cold water shall not be applied to massive members immediately after striking the form work, while the concrete is still warm. Alternate wetting and over drying shall be avoided.



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Curing by spraying water shall be continued at least for 18 days after final setting.

4.19.4 Curing of concrete with absorbent material kept damp

The entire concrete surface is covered either with hessian, burlap, sawdust, sand, canvas or similar material and kept wet continuously for at least 12 days after final setting.

4.20 Testing of Concrete

4.20.1 General

The Contractor shall carry out, entirely at his own cost, all sampling and testing in accordance with the relevant I.S. standards and as supplemented herein. The Contractor shall get all tests done in approved Laboratory and submit to the Engineer, the test result in triplicate within 3 days after completion of the test.

4.20.2 Consistency test (tests of fresh concrete)

4.20.2.1 At the place of deposition/pouring of the concrete, to control the consistency, slump tests and/or compacting factor tests shall be carried out by the Contractor in accordance with I.S. 1199-1959 as directed by the Engineer.

4.20.2.2 The results of the slump tests/compacting factor tests shall be recorded in a register for reference duly signed by both the Contractor and the Engineer. That register shall be considered as the property of the Owner and shall be kept by the Contractor at site in safe custody.

4.20.2.3 The results of the slump tests/compacting factor tests shall tally, within accepted variation of plus or minus 12% with the results in the respective design mix, in case of mix design concrete and with the values indicated in the table under clause 6.1 of IS: 456 in case of nominal mix concrete.

4.20.2.4 For any particular batch of concrete, if the results do not conform to the requirements as specified in 4.20.2.3 or do not conform to any requirement of this specification, the Engineer has the right to reject that batch and the Contractor shall remove the same immediately from the site, at no cost to the Owner.

4.20.3 Strength test of concrete

4.20.3.1 While placing concrete, the Contractor shall make 6 nos. of 15 cm test cubes from particular batches of concrete as desired by the Engineer. The frequency of taking test cubes shall be either according to clause 14.2 of IS: 456-2000 or as directed by the Engineer.

4.20.3.2 The cubes shall be prepared, cured and tested according to IS: 516-1959. Out of 6 nos. of test cubes 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting.

4.20.3.3 A register shall be maintained at site by the Contractor with the following details entered and signed by both the Contractor and the Engineer. That register shall be considered as the property of the Owner.



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- (a) Reference to the specific structural member
- (b) Mark on cubes
- (c) The grade of concrete
- (d) The mix of concrete
- (e) Date and time of casting
- (f) Crushing strength at 7 days
- (g) Crushing strength at 28 days
- (h) Any other information directed by the Engineer.

4.20.4 Acceptance criteria for test cubes

The acceptance criteria of concrete on strength requirement shall be in accordance with the stipulations under clause 15 of IS: 456-2000.

Non-destructive tests on hardened concrete

If there is doubt about the strength or quality of a particular work or the test results do not comply with the acceptance criteria as stipulated under clause 5 of IS: 456- 2000, non-destructive tests on hardened concrete like core test and/or load tests or other type of non destructive tests like ultrasonic impulse test etc. shall be carried out, as may be directed by the Engineer, by the Contractor at entirely his own cost.

4.20.5.2 The core tests and load tests shall comply with the requirements of clause 16.3 and 16.5 of IS: 456-2000 respectively. In case of other types of special tests like ultrasonic impulse test etc., the stipulation of clause 16.6 of IS: 456-2000 shall be applicable.

4.20.6 Concrete below specified strength

In case of failure of test cubes to meet the specified requirements the Engineer may take one of the following actions:-

- 1) Instruct the Contractor to carryout additional test and/or works to ensure the soundness of the structure at Contractor's expense.
- 2) Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at Contractor's expense and the resultant structures affected due to such rejection shall be made good at contractor's expense.
- 3) Modification/remedial measures if approved by the engineer to be carried out at contractor's expense.
- 4) Accept the work with reduction in the rate in appropriate item subject to the provisions of clause 15 of IS 456-2000 provided it is technically acceptable. The reduction in the rate shall be as given below :-



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- i) When test strength of the sample is above 90% of the characteristic strength, payment shall be made 10% less than the contract rate.
- ii) When test strength of the sample is between 80-90% of the characteristic strength, payment shall be made 25% below than the contract rate.

4.20.7 Concrete failed in non-destruction tests

In case the test results of the core tests or load tests in a particular work do not comply with the requirements of respective clause (16.3 for core test and 16.5 for load tests) of IS: 456-2000 the whole or part of the work concerned shall be dismantled and replaced by the Contractor as may be directed by the Engineer at no extra cost to the Owner and to the satisfaction of the Engineer. No payment for the dismantled concrete including relevant form work, reinforcement, embedded fixtures etc. shall be made. In the course of dismantling if any damage occurs to the adjacent structure or embedded item, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

4.21 Steel Reinforcement

4.21.1 Material

Material shall be as specified in the respective schedule of Items. The specifications of materials shall be as per Part-I.

4.21.2 Storage

Steel reinforcement shall be stored in such a manner that they are not in direct contact with ground. Bars of different classifications and sizes shall be stored separately. In cases of long storage or in coastal areas, reinforcement shall be stacked above ground level by at least 15 cm, and a coat of cement wash shall be given to prevent scaling and rusting at no extra cost of the owner.

4.21.3 Bending and placing

Bending and placing of bars shall be in conformity with IS: 2502-1963 "Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement" and IS: 456 -2000 "Code of Practice for Plain and Reinforced Concrete".

4.21.4 Welding of Reinforcement

Welding of mild steel reinforcement bars conforming to IS:432 (Part-I)-1982 shall be done in accordance with IS: 2751 -1979 "Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete construction" with additional precaution that for lap welded joints the throat thickness of weld beads shall be at least 3 mm or 0.6 times the nominal size of weld (which is the radius of bar) whichever is more.

Welding of cold worked high strength deformed bars conforming to IS: 1786- 2008 shall be done using electric arc welding process using low hydrogen electrodes (Ferro Weld- I or Ferro Weld-II or equivalent). Oxy-acetylene welding shall not be used.



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Butt welding of bars upto 32 mm diameter for vertical splices shall be done either by single bevel groove weld or double bevel groove weld, with bevel angle 45 degree. Butt welding of bars upto 32 mm diameter for horizontal splices shall be done either by single Vee-groove weld or double Vee-groove weld with chamfered angle of 45 degree to 60 degree. The diameter of welded joint shall be 1.2 times the diameter of bar. Edge preparation for butt welding shall be done by shearing, machining and grinding. Oxy-acetylene flame shall not be used for cutting. Chamfered faces shall be smooth finished by hand file if required.

Lap welding of bars upto 20 mm diameter shall have a minimum bead length of 12 times the diameter of bar or 200 mm whichever is more arranged on one or both sides. The throat thickness of weld beads shall be 5 mm or 0.75 times the nominal size of weld (which is the radius of bar) whichever is more. In case of unsymmetrical lap weld with weld bead on one side only, the maximum length of each weld bead shall be 6 times the diameter of bar or 100 mm (whichever is more), separated by an equal length in between weld beads. Splice bars used in symmetrical weld joint shall have same diameter as the parent bars. Lap joint with single splice bars shall have weld beads on both sides.

Lap welding of bars above 20 mm shall be done using splice plate or splice angle. Thickness of splice plate shall not be less than 0.65 times the diameter of bar and width shall not be less than twice the diameter of bar. The size of splice angle shall be such that its area of cross section is at least 1.62 times the area of bar being spliced.

More than one third of the bars shall not be welded at any one section and welded joints shall be staggered at a distance of 50 times the diameter of bars. Welding shall not be done at bends or curved parts of bars and it shall be located at least at a distance of 50 times the diameter of bar from bends.

Tests

Test pieces of welded bars shall be selected and tested in accordance with the provisions of IS: 2751-1979. The number of tests will be as laid down in IS: 2751-1979 or such larger number as the Engineer may decide having regard to the circumstances.

4.21.5 Cleaning All steel for reinforcement shall be free from loose scales, rust coatings, oil, grease, paint or other harmful matters immediately before placing the concrete. To ensure this, reinforcements with rust coatings shall be cleaned thoroughly before bending/placement of the same.

4.21.6 Placing in position

All reinforcements shall be accurately fixed and maintained in positions as shown on the drawings and by adequate means like mild steel chairs and/or concrete spacer blocks as required. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by 20G annealed soft steel wire or by tack welding in case of bars larger than 25 mm dia, as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layers of bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers.



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4.21.7 Clear cover

Clear cover shall be as specified in the drawings. If nothing is specified in the drawing the clear cover shall be in accordance with the relevant clause of IS: 456- 1978.

Light structural work and embedded metallic parts, conduits

4.21.8.1 Fabrication of metallic parts & light structural works

Fabrication of all structural steel work shall be done in accordance with IS: 800 - 2007 "Code of Practice for use of Structural Steel in General Building Construction". Workmanship shall match to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part and all identical parts shall be strictly interchangeable. Steel work shall be shop fitted and shop assembled as far as practicable to minimise site work and to meet transport restrictions. All materials shall be straight and if necessary before being worked shall be straightened or flattened by pressure and shall be free from twists. Shearing or flame cutting may be used and the resulting edges shall be clean and straight. Flame cut edges shall be planed/cleaned by chipping or grinding. Sheared members shall be free from distortion at sheared edges. Welding and welded work shall conform to IS: 816 -1969 "Code of Practice for use of metal arc welding for General Construction in Mild Steel". Mild steel electrodes conforming to IS: 814-2004 "Specification for covered electrodes for metal arc welding of mild steel shall be used.

Transportation and Storages

All pieces shall be properly identified and bundled for transportation to work site. Care shall be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials shall be kept free of dirt, grease and foreign matter and shall be stored properly on skids or any other suitable supports to avoid contact with ground, damage due to twisting, bending etc.

4.21.8.3 Erection of light structural work

Erection of light structural work shall be carried out in accordance with the provisions of IS: 800-2007. No component which is bend or twisted shall be put in place until the defects are corrected. Components seriously damaged during handling shall be replaced. No riveting, permanent bolting or welding shall be done until proper alignment has been completed. Whenever field welding is to be done it shall be in accordance with the requirements of shop fabrication. Shop paints shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

4.21.8.4.1 Erection of embedded metallic parts, inserts, conduits

Bolts and inserts shall be securely fixed in position as shown in the drawings, before commencement of concreting. Bolts shall be checked for accuracy in alignment on both the axes. Limits of tolerance in alignment and level shall be as shown in the drawing or described elsewhere in these specifications.



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Where bolts are housed in sleeves, special care shall be taken after concreting is over and has partly set to ensure that the bolts move within the sleeves. The annular space of the sleeve shall be plugged with suitable stoppers to prevent the ingress of water, grout, dust, rubbish or other foreign material into it, both during and after concreting. Opened conduits shall be plugged similarly and conduits laid on earth shall suitably encased with Plain Cement Concrete. Where channels, Unshapely profiles or other similar inserts are required to be placed in concrete, special care shall be taken to keep the grooves of such profiles free from the ingress of concrete, slurry etc., by suitable packing material, if necessary.

All threads for bolts and inserts shall be greased at intervals and kept covered to prevent damage.

4.21.8.4.2 Necessary templates, jigs, fixtures, supports shall be used as may be specified or required or directed by the Engineer free of cost to the Owner.

Exposed surfaces of embedded materials shall be painted with one coat of anticorrosive paint or bituminous paint, as desired, without any extra cost to the Owner. If welding is to be done subsequently on the exposed surfaces of the embedded parts, the painting for a length of 50mm beyond each side of the weld line shall be cleaned off.

4.22 Shuttering

4.22.1 General

All shuttering, formwork, supports and staging shall be designed by the Contractor and be subject to approval by the Engineer. The Contractor shall submit drawings and calculations to the Engineer for scrutiny when called upon to do so. The shuttering shall be designed for a live load of 400 Kg/m² in addition to the weight of the green concrete, or such other load as the Engineer may specify. The Contractor shall be responsible for the correctness and strength of the formwork including its supports and centering and approval by the Engineer will not relieve him of his responsibilities.

4.22.2 Material

The staging and supports may be of round or sawn timber or tubular or other shapes in steel. Round timber shall preferably extend over the full height in one piece. These shall be securely jointed or otherwise fastened and spaced at suitable intervals as the design may warrant and shall be suitably braced at regular intervals horizontally and diagonally.

The form work shall be of steel plate on steel frame, wooden boards with steel sheet lining, or plywood or seasoned timber board. Where ornamental and curved surfaces are required the material shall be very good seasoned timber or plywood which can be shaped correctly.

4.22.3 Fixing

The shuttering shall conform to the shapes, lines, levels and dimensions shown in the drawing. It shall be fixed in perfect alignment and securely braced so as to be able to withstand, without appreciable displacement, deflection or movement of any kind, the weight of all construction, movement of persons and plant. It shall be so constructed as to remain rigid during the placing



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and compacting of concrete without shifting or yielding and shall be sufficiently water tight to prevent loss of slurry from the concrete.

All props shall be supported on sole plates and double wedges. At the time of removing props these wedges shall be gently eased and not knocked out. The form work shall be so designed that the sides are independent of the soffits and the side forms can be removed easily without any damage or shock to the concrete.

4.22.4 Wrought shuttering

Wrought shuttering shall be such as to produce a first class fair face on the concrete free from board marks or any other disfigurements. This shall be used for exposed surfaces where specified or directed by the Engineer. It may be made of heavy quality plywood or steel sheets having smooth, plain surface. The joints in shuttering shall be arranged in a regular pattern approved by the Engineer. Wrought shuttering shall be aligned within a tolerance of 3 mm.

4.22.5 Rough shuttering

Rough shuttering shall be used for all surface of concrete walls, footings etc., which are not exposed in the finished work or which are to receive plaster and as directed by the Engineer. It may be made of timber, ordinary plywood or steel sheets.

4.22.6 Special provision

4.22.6.1 Wherever concreting of narrow member is required to be carried out within shutters of considerable depth, temporary openings in the sides of the shutters shall, if so directed by the Engineer, be provided to facilitate cleaning, pouring and consolidation of concrete.

4.22.6.2 In liquid retaining structures and structures below ground water level, through bolts for the purpose of securing and aligning the form work shall not be used.

4.22.6.3 Forms shall be given an upward camber, if so desired by the Engineer, to ensure that long beams do not have any sag. The camber may be 1 in 250 or as the Engineer may direct.

4.22.6.4 The joints in form work shall be sealed by adhesive tapes or by other means, to prevent any leakage of slurry or mortar if so directed by the engineer.

4.22.7 Preparation for concreting

Before any concreting is commenced the shuttering shall be carefully examined for dimensional accuracy and safety of construction. The space to be occupied by concrete shall be thoroughly cleaned out to remove rubbish, debris, shavings and saw dust. The surface in contact with concrete shall be coated with an approved substance such as mould oil or other nonstaining mineral oil to prevent adhesion. Where necessary the surface shall be wetted to prevent absorption of moisture from concrete. Care shall be taken to avoid the reinforcements coming in contact with shutter oil.

4.22.8 Removing



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4.22.8.1 Removal of forms shall never be started until the concrete has thoroughly set and aged to attain sufficient strength to carry twice its own weight plus the live load that is likely to come over it during construction

4.22.8.2 Removal of forms shall not entail chipping or disfiguring of the concrete surface. Shuttering shall be removed without shock or vibration and shall be eased off carefully in order to allow the structure to take up its load gradually.

4.22.8.3 Under normal circumstances (generally where temperatures are above 21 degree 'C'), and where ordinary portland cement is used shuttering may be struck after the expiry of the following periods :-

Walls, columns & vertical faces	24 to 48 hours as may be directed by the Engineer.
Bottom of slab upto 4.5 m span	7 days
Bottom of slab above 4.5 m span, bottom of beam and arch, rise upto 6 m span	14 days
Bottom of beam and arch rise over 6 m span	21 days

These periods may be increased at the discretion of the Engineer. Special care shall be taken while striking the shuttering of cantilevered slabs and beams, portal frames etc.,

4.22.8.4 Before removing the form work, the Contractor must notify the Engineer to enable him to inspect the condition of the finished concrete immediately after the removal of the form works.

4.22.9 Contractor's responsibility

Any damage resulting from faulty preparation, premature or careless removal of shuttering shall be made good by the Contractor at his own expense.

4.22.10 Irrecoverable shuttering

In cases where the shuttering cannot be removed without damaging the structure itself or where removal of shuttering is rendered impossible due to the nature of construction or where the Engineer may so instruct, such shuttering shall be classified as irrecoverable shuttering. However, such abandoning of shuttering will be permitted only in situations where it will not remain exposed or otherwise cause damage of any kind.

4.22.11 Metal Forms

Where permanently left-in-place metal forms or deck are shown in drawings or otherwise ordered to be provided by the Engineer, they shall satisfy the requirements with regard to load carrying capacity. The metal forms shall be obtained from a reputed manufacturer, whose performance guarantee shall be obtained and submitted to the Engineer. Designs and drawings giving full details shall be submitted to the Engineer in advance for approval.



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4.23 Damp Proof Course Concrete

4.23.1 Thickness

It shall be as specified in the drawings or in the items.

4.23.2 Mix

The grade of mix shall be as specified in the drawing or schedule of quantities. If nothing is specified, the mix shall be 1 part of cement : 1 1/2 part of coarse sand : 3 parts of stone chips. The stone chips shall be 12 mm down graded.

Approved water proofing admixture shall be mixed with cement as per manufacturer's specifications. The water cement ratio shall be as low as possible to increase the impermeability of concrete and in no case more than 0.5. 4.23.3 Preparation of base surface

The base surface shall be well roughened by chipping and brushing with steel brush and shall be cleaned of all dirt, dust, grease, oil and all other foreign & deleterious materials. Then the surface shall be well moistened with water.

4.23.4 Placing and compaction

Just prior to placement of D.P.C. Concrete, a thick coat of cement slurry shall be applied on the base surface. The placement shall be as specified for the concrete in beams. The concrete shall be well compacted to make it dense.

4.23.5 Finishing

When the concrete has set enough but remains still green, the top surface shall be marked in regular pattern by steel trowel so as to have proper bond with the future work.

4.23.6 Curing

The D.P. course shall be kept continuously moist at least 10 days.

4.24 Grout

4.24.1 Scope

The scope covers the grouting under base plates, grouting between the joints of precast concrete, grouting the pockets/holes/opening etc.

4.24.2 Grouting under base plates

Grouting under base plates of equipments/structures shall be non-shrink cementitious Grout of compressive strength M-40 (40 N/mm²). The grout shall be placed in position well rammed until the whole space is completely filled with concrete. No vibrators shall be used. Quick setting cements shall be used in the preparation of mortar or concrete, where so specified. Grout shall be place in accordance with the Manufacturer's instructions.



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4.24.3 Grouting the pockets/holes in concrete

Same as Grout under base plate.

4.24.4 Workmanship

4.24.4.1 The surface of the concrete over which grouting is to be applied shall be thoroughly prepared to provide a clean rough surface. If necessary, chipping shall be carried out on such surface to make it completely rough. Then the surface shall be wetted. Bolt pockets shall be cleaned immediately before the base plate is placed in position. Before grouting the surface shall be thoroughly cleaned with compressed air/water jet.

4.24.4.2 Before placement of grout, the surfaces (except in the case of bolt holes) shall be wetted with cement slurry. In case of bolt holes/pockets water from such pockets shall be thoroughly removed by some suitable means and no cement slurry shall be applied.

4.24.4.3 Hand mixing is not permitted and the grout shall always be machine mixed. If however in some special cases where the quantity of grout is so small that it cannot be machine mixed, hand mixing may be allowed but the same shall be done under the strict supervision of an experienced supervisor of the Contractor.

4.24.4.4 The grout shall be placed within 30 minutes of being mixed. The grout shall be poured and then worked into position by suitable means until the space is completely filled. The Contractor shall take all possible measures during grouting so that the grout fills the space completely and thoroughly.

4.24.5 Curing

After 10 hours of grouting, the same shall be covered with wet gunny bags and the surface shall be kept continuously moist at least for 10 days.

4.25 Concreting in Water Retaining Structures

General requirements

The basic specifications as regards 'mix' design, placing, compacting, curing etc. shall conform to the requirements as specified herein before in this Chapter. Over and above the materials and workmanship shall conform to the stipulations of IS: 3370 (Part-I & II)-1965 to make dense and impervious concrete. As specified herein before all the construction joints shall be provided with approved Chemical treatment. The expansion and construction joints, if any, shall be provided with the requirements as specified in the drawing or as directed by the Engineer.

4.26 Application of Live Load

The designated live load shall be allowed on any structure only after 28 days, after proper curing is carried out on the last concrete poured in structure.

4.27 Foam Concrete



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This shall be of average 50mm thickness or as specified or as shown on the drawings. This may be laid in in-situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m²h/degree C. The weight of the insulating material shall be from 0.5 to 0.75 gm/cm³, strength not less than 5 Kg/sq.cm or (0.5N/sq.mm.). In general, the main ingredients of Foam Concretes are cement, fly ash and foaming agent and the work shall be carried on by specialised Agencies/Companies. Before starting the laying of foam concrete sample shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to take the usual work loads and standard loads expected on the roof. Any damaged portion shall be removed and replaced forthwith. Approval of the Engineer shall be taken before laying the waterproofing over the insulation.

While laying the foam concrete, sample batches of mix shall be kept for test if so desired by the Engineer.

5.0 Masonry

5.1 General

This specification deals with masonry and allied works in foundation, plinth and superstructure.

5.2 Materials

For specifications of materials Part-I shall be referred.

5.3 Selection of Mortars

Mortar for masonry shall conform generally to IS: 2250-1981 "Code of Practice for Preparation and Use of Masonry Mortars", and proportion shall be as specified in the drawing or in the Schedule of Items.

5.4 Cement Mortar

5.4.1 Cement mortar shall be prepared by mixing cement and sand in specified proportion. It is convenient to take unit of measurement for cement as a bag of cement weighing 50 Kg equivalent to 0.035 cubic metre. Sand is measured in boxes of suitable size (say of 40 x 35 x 25 cm). It shall be measured on the basis of dry volume. In case of damp sand, the quantity shall be increased suitably to allow for bulkage in accordance with IS:2386-1963 (part-III) or by any approved method. 5.4.2 The mixing of the mortar shall be done preferably in a mechanical mixer. This condition may be relaxed by the engineer taking into account the nature, magnitude and location of the work.

If mixed in the mixer, cement and sand in the specified proportion shall be fed in the mixer and mixed dry thoroughly, water shall be then added gradually and wet mixing continued for at least 3 minutes. In case of hand mixing also after mixing dry on a water-tight masonry platform, water shall be added and the mortar turned over and over, backward and forward several times.

5.4.3 Fresh mixed mortar, in case becoming stiff due to evaporation of water may be retempered by adding water as frequently as needed to restore the requirement of the



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consistency but this shall be permitted only upto a maximum of 2 hours from the time of addition of cement in the mortar.

5.5 Brick Work

5.5.1 Storage and handling bricks

Bricks shall not be dumped at site. They shall be carefully handled and carefully stacked in regular tiers to avoid breakage and defacement of bricks and prevent contamination by mud or other materials. The supply of bricks shall be so arranged that as far as possible at least two days' requirement of bricks is available at site at any time. Bricks selected for different situations of work shall be stacked separately.

5.5.2 Soaking & Cleaning bricks

Bricks required for masonry shall be cleaned to be free from dirt, dust and sand and fully soaked in clean water by submerging in vats before use, till air bubbling ceases. The bricks shall not be too wet at the time of use. After soaking they shall be removed from the tank sufficiently early so that at the time of laying they are skin dry and stacked on a clean space.

5.5.3 Setting out

The building lines shall be set out by the Contractor as per clause 7 of IS: 2212- 1991 and got checked by the Engineer.

5.5.4 Laying of bricks

5.5.4.1 Brickwork in general shall be as per IS 2212-1991. Bricks shall be laid in English bond, unless otherwise specified, with frogs upward over a full bed of evenly laid mortar, and slightly pressed and tapped into final position to the lines levels and shape as shown in the drawing fully embedded in mortar. All joints including inside faces shall be flushed and packed. Not more than 8 courses shall generally be laid in a day. The first course itself shall be made horizontal by providing enough mortar in the bed joint to fill up any undulations. The horizontality of courses and the verticality of wall shall be checked very often with spirit level and plumb bob respectively.

5.5.4.2 Horizontal joints shall be truly horizontal and vertical joints shall line up in every alternate course. The joints shall not exceed 10 mm in thickness and shall be well finished and neatly struck. The joints shall be kept uniform throughout the brick work. All the brick joints of the face works shall be neatly raked out to a minimum depth of 15 mm with the help of raking tools and the faces of brick wall cleaned with wire brush to remove any splashes of mortar before the close of the day's work, while the mortar is still green and the last brick layer shall be cleaned with wire brush and the frogs free from mortar.

5.5.4.3 Walls coming in contact with R.C.C. structures shall perfectly be bonded with M.S. inserts or lugs where shown on drawings and the sides butting against the R.C.C structures neatly and efficiently flashed and packed with rich mortar & cement slurry at no extra cost (cost of M.S. inserts or lugs used shall be measured and paid separately under relevant items).



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Where such lugs are not required to be provided, brick work shall be built tightly against columns, slabs or other structural parts, around door and window frames with proper distance to permit caulked joint. Where drawings indicate structural steel column or beam to be partly or wholly covered with brick work, bricks shall be built closely against all flanges and webs, with all spaces between steel and brick work filled solid with mortar not less than 10 mm thick.

5.5.4.4 Damaged or broken brick or brick bats shall not be used in brick work. Cut bricks may be used to complete bond or as closers or around irregular openings.

5.5.4.5 Bricks shall not be thrown from heights to the ground, but shall be handled carefully and put gently in position to avoid damaging their edges.

5.5.4.6 Selected bricks of regular shape and dimension shall be used for face work.

5.5.4.7 Making of grooves, sleeves and chases shall be done, during the construction, to the lines, levels and position as shown in the drawing or as instructed by the Engineer. Such sleeves shall slope outward in external walls so that their surface cannot form channels for the easy passage of water inside.

5.5.4.8 Fixtures, plugs, frames, pipes, inserts etc., if any, shall be built in at the right places to the lines & levels as shown in the drawings while laying the course and not later by disturbing the brick work already laid.

5.5.4.9 Brick walls of one brick thick or less shall have one selected face in true plane and walls more than one brick thick shall have both the faces of wall in true plane.

5.5.4.10 All connected brick work shall be carried out simultaneously with uniform heights throughout the work, and in exceptional cases, with the approval of the Engineer, the brick work built in any part of the work may be lower than another adjoining wall/connected wall by a maximum of one metre and the difference in height of adjoining wall/connecting wall shall be raked back according to bond by stepping at an angle not steeper than 45 degree, without sacrificing the necessary bond, horizontality of layers, verticality of joints and the wall. Tothing shall not be allowed in brick work, for raking back. The top layer just below the R.C.C slab or beam shall be laid with frogs down over a layer of mortar on full width.

5.5.4.11 Openings in brick work

Openings shall be made in brick work, which may be of any shape, size, at all levels, heights or depths, including round openings, as shown in the drawing or as directed by the Engineer, maintaining the necessary bond using a minimum of cut bricks. Openings in external face walls, the sills, jambs, soffits of opening may be rebated and the sill shall be sloped slightly for drainage of rain water.

5.5.4.12 All exposed brick work shall be rubbed down, thoroughly washed, cleaned and pointed as specified. Where face bricks of specific quality are used the same shall be rubbed with carborundum stone.

5.5.5 Half-brick masonry



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5.5.5.1 Half-brick work shall be done in the same manner as for brick work except that all courses shall be laid in stretchers. Both faces shall be true to plane and the joints raked on both faces.

Where reinforcement is considered necessary or specified and shown in drawing, M.S. bars or hoop iron shall be provided as stipulated in the Schedule of Items or as directed by the engineer. The reinforcement shall be cleaned of rust and loose scale with a wire brush, and shall be laid straight on the mortar and lapped with the dowel bars provided in the column, securely anchoring them at their ends where the half-brick wall butts. The batching of mortar usually shall be in the proportion of 1:4 or as stipulated in the Schedule of Items. Half of the mortar for the joints shall first be laid and the other half laid after the reinforcement is laid in position, so that the reinforcement is fully embedded in position.

5.5.6 Brick on edge masonry

The work brick on edge masonry wall in superstructure shall be done in the same manner as mentioned for brick work except that it shall always be reinforced with wire mesh netting of approved variety as specified in the item and embedded in cement mortar at interval as specified in the Schedule of Items. The wire netting shall be continuously laid and securely anchored with the dowel bars provided & projecting from the walls/RCC structure or steel structures at their ends where brick on edge wall butts. The batching of mortar usually shall be in the proportion of 1:3 or as stipulated in the Schedule of Items.

5.5.7 Protection of brick work

The brick wall shall be protected and covered with gunny bags or water proof sheets from the effects of inclement weather, rain, frost, etc., during the construction and until the mortar sets. Care shall be taken during construction that the edges of jambs, sills and soffits of openings are not damaged.

5.5.8 Curing

All brick works shall be kept moist for 10 days after laying.

5.5.9 Scaffolding

5.5.9.1 Necessary and suitable scaffolding shall be provided at all heights to facilitate the construction of brick wall. Scaffolding shall be sound, strong and all supports and other members shall be sufficiently strong and rigid, stiffened with necessary bracings and shall be firmly connected to the walls securing them against swing or sway. Planks shall be laid over the scaffolding at required levels. Scaffolding shall preferably be of tubular steel, although the Engineer may permit other material, depending upon the circumstances.

5.5.9.2 Scaffolding shall be double, having two sets of vertical supports, particularly for the face wall and all exposed brick work. Single scaffolding may be used for buildings upto two storeys high or at other locations, if permitted by the Engineer. In such case the inner ends of horizontal members shall rest in holes provided in header course only. Such holes shall not be allowed in pillars under one metre in width, or immediately near the skew backs or



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arches. The holes thus left in masonry shall be filled with bricks set in rich mortar and the surface made good on removal of scaffolding.

5.5.9.3 If for any reason the Contractor is required to erect scaffolding in property other than that belonging to the Owner, including municipal corporation or local bodies, necessary permission shall be obtained by the Contractor from the appropriate authorities and necessary licensing fees if any shall have to be borne by him.

5.5.9.4 All scaffoldings once erected shall be allowed to remain in position, efficiently maintained by the Contractor, till all the finishing works required to be done are completed and shall not be removed without the approval of the Engineer.

The Contractor shall allow workmen of other trades to make reasonable use of the scaffolding without any extra cost.

6.0 Boulder Soling

The width of the soling coat shall be 30cm (15cm on either side) more than that of the wearing coat. Its depth shall be 15cm in cutting and 23cm in filling and made up soil, unless otherwise specified in the schedule of quantities or shown in the drawing.

The edges of the soling shall be marked out by strings and stakes. Soling stone shall be hand packed and set on edge with greatest length across the road. This shall be laid closely in position on the sub-grade, firmly set with their broadest side downwards. The joints shall be staggered. All interstices between the stones shall be wedged in with locking smaller stones well driven into gaps to ensure tight packing and complete filling of interstices. Such filling shall be carried out simultaneously with the placing in position of soling stones and shall not lag behind.

After packing, surface shall be checked with template of approved shape and high and low spots corrected by removing soling and re-packing. The top surface of the soling coat shall be perfectly true to camber and grade.

The soling shall then be thoroughly consolidated with power roller of 8-12 tonne weight depending upon the type of soling stones, starting at "edges" and working towards the centre. In case of super-elevated curve the rolling shall commence from the inside edge of the curve to the outside edge. The roller shall run over the same surface of soling at least 10 times or more till the soling coat is well consolidated to the satisfaction of the Engineer. The surface shall be checked by templates and any disturbance in grade or camber corrected after every rolling and finally consolidated. After that, at least 50mm thick moorum shall be laid on top of soling coat and rolled with water to proper compaction so that the top surface seems smooth. The rate for soling coat shall be inclusive of the cost of the moorum as blinding materials for which no separate payment shall be made.

7.0 Laterite soling

In case of laterite soling the thickness of soling shall be as follows:



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- (i) For road width of 7m and above the sub-base shall consist of two layers of laterite stones 150mm maximum size. The sub-base shall be rolled to a thickness of 230mm after compaction.
- (ii) For road width of 4m to 7m, the sub-base shall consist of one layer of laterite stone of 150mm maximum size consolidated to 115mm thick.
- (iii) A layer of moorum, 33.3 % in volume of laterite, shall be spread over the laterite to a uniform thickness and rolled with 8 tonne roller with constant watering until the mixture penetrates into the voids of laterite layer. Care shall be taken to maintain the camber and slopes. Other steps for laying, compacting etc. of the laterite soling shall be same as given under clause 14.4.1 "Boulder soling".

8.0 Kerbs

Concrete or stone kerbs, where shown in drawings, shall be fixed in position after laying and consolidation of soling. They shall be fixed true to line and level and secured in position by approved means.

9.0 Expansion and Isolation Joints

9.1.1 General Expansion and isolation joints in concrete structures shall be provided at specific places as per details indicated on the drawings. The materials and types of joints shall be as specified hereinafter. In case of liquid retaining structures, additional precautions shall be taken to prevent leakage of liquids as may be specified on the drawings or as directed by the Engineer. All materials are to be procured from reliable manufacturers and must have the approval of the Engineer. Where it is the responsibility of the Contractor to supply the material, the Engineer may demand test certificates for the materials and/or instruct the Contractor to get them tested in an approved laboratory free of cost to the Owner. Joints shall be formed true to line, level, shape, dimension and quality as per drawings and specifications. Prior approval, for the method of forming the joints, should be obtained from the Engineer before starting the work.

9.1.2 Joint sealing strips

9.1.3 General

Joint sealing strips may be provided at the construction, expansion and isolation joints as a continuous diaphragm to contain the filler material and/or to exclude passage of water. The sealing strips will be either metallic like G.I., Aluminum or Copper, or Non-metallic like rubber or P.V.C.

Sealing strips will not have any longitudinal joint and will be procured and installed in largest practicable lengths having a minimum number of transverse joints. The jointing procedure shall be as per the manufacturer's recommendations, revised if necessary, by the Engineer. If desired by the Engineer, joints in rubber seals may have to be vulcanised.

9.1.4 Metal sealing strips



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Metal sealing strips shall be either G.I. or Aluminium or Copper and formed straight, U-shaped, Z-shaped or any other shape and of thickness as indicated in the drawing and schedule of items and/or as instructed by the Engineer.

The transverse joints will be gas welded using brass rods and approved flux. In case it is found that the joints cannot be made leak proof, longer lap lengths and different method of brazing which will render it leak proof, will be adopted by the Contractor without any additional cost to the Owner. The edges shall be neatly crimped and bent to ensure proper bond with the concrete.

a) G.I. Strips

G.I. strips shall be minimum 1.5 mm thick and 150 mm in width unless specified otherwise. The Strips shall be strong, durable, without any rust or crease. At the joints, the overlapping should be for a minimum length of 50mm

b) Aluminium strips

Aluminium strips shall be minimum 18 SWG thick and 300 mm wide unless specified otherwise and shall conform to IS : 737-1986. A minimum lap of 50 mm length is required at the joints.

c) Copper strips

The copper strips shall be minimum 18 SWG in thickness and 300 mm width.

It should be cleaned thoroughly before use so as to expose fresh surface, without any reduction in gauge. A minimum lap of 50 mm in length is required at the joints.

9.1.5 Non-metallic sealing strips

These will be normally in Rubber or PVC Rubber or PVC joint seals can be of shape having any combination of the following features :

- a) Plain
- b) Central bulb
- c) Dumb-bell or flattened ends
- d) Ribbed and corrugated wings
- e) V-shaped

Transverse joints will be allowed only under unavoidable circumstances and with the specific approval of the Engineer. The actual size and shape shall be as shown in drawings/Schedule of Items and or as directed by the Engineer.



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

a) Rubber sealing strips

The minimum thickness of rubber sealing strips shall be 3 mm and the minimum width 100 mm. The material will be natural rubber and be resistant to corrosion, abrasion and attacks from the acids, alkalies and chemicals normally encountered in service. The physical properties will be generally as follows :

Specific Gravity	:	1.1 to 1.15
Shore Hardness	:	65A to 75A
Tensile Strength	:	25 - 30 N/mm ²
Maximum Safe Continuous Temperature	:	75 Degree 'C'
Ultimate Elongation	:	Not less than 350%

b) P.V.C. sealing strips

The minimum thickness of P.V.C sealing strips will be 3 mm and the minimum width 100 mm. The material should be of good quality Polyvi- nyl Chloride highly resistant to tearing, abrasion and corrosion as well as to chemicals likely to come in contact with during use. The physical properties will generally be as follows :

Specific Gravity	:	1.3 to 1.35
Shore Hardness	:	60A to 80A
Tensile Strength	:	10 - 15 N/mm ²
Maximum Safe Continuous Temperature	:	70 Degree 'C'
Ultimate Elongation	:	Not less than 275%

9.1.6 Bitumen compound

When directed, the gap in expansion joints shall be thoroughly cleaned and bitumen compound laid as per manufacturer's specifications. The compound to be used shall be of approved manufacture and shall conform to the requirements of IS: 1834-1984.

10.0 Pure epoxy resin based anchoring of Bars and Anchors by Rebaring

Description: Anchoring shall be done with pure epoxy resin based chemical anchoring mortar. The product should be specially designed for applications where heavy loads under critical conditions are to be fixed in concrete. Product should be correctly mixed in the mixing nozzle during application.



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10.1.1 Fields of application Product should be typically used in highly technical fixing situations like:

- Anchoring of rebars in preformed holes in concrete
- Fixing of anchoring bolts exposed to heavy loads
- Installation of bonded rebars / shear reinforcement

10.1.2 Product properties should reflect

- High adhesive power
- Fast curing time
- Easy to extrude
- Styrene free formulation – low odour
- High mechanical strengths
- Should be used in diamond drilled holes
- Applicable in slightly damp conditions
- Should be used at high temperatures
- Should have very low shrinkage, even on big diameters
- Should be for interior and exterior use
- Specially suitable for technical applications
- For fixing in solid material like concrete or brickwork

10.1.3 Precautions:

The performance, durability and safety of the installed product used for anchoring steel (rebar) strongly depends on the substrate, the dimensions of the element, the drilling and cleaning of holes, the substrate temperature and the type of anchoring bolt or bar. It is therefore important that a proper structural assessment of the structural elements to be repaired should be carried out by qualified engineers, and that the choice of products, anchor types etc should be based upon such assessment.

10.1.4 Application principles

Preparation

The substrate must be clean, structurally sound, and without substances which can have a negative effect on the adhesion of the chemical anchoring mortar.

Holes



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Holes can be made using diamond or hammer drilling machines. Depth and diameter of the holes are to be determined by the substrate, effective loads and the diameter of the anchor bolts or rebars. The drilled holes need to be cleaned with round brushes and oil-free compressed air directly from a compressor or using special hand pumps. The substrate can be damp, but must be without free standing water.

Application as structural adhesive

Before adhering metal plates, guardrails etc the substrate should be prepared leaving a clean and slightly rough surface. Clean the metal parts to bright steel and oil or grease shall be removed from the surface of these elements.

The application Procedures shall follow manufacturer's guidelines and all work shall be carried out by approved applicator as per manufacturer's specification.

A pullout test shall be carried out at an approved laboratory for at least two diameters of bars to ascertain the design properties of the anchored bars. No extra payment shall be made for conducting the tests

Epoxy Anchoring Grout shall be (such as MASTERFLOW 935 of BASF /SIKA ACHOROFIX-2 of SIKA ShaliGrout Anchor of STP/Lokfix of Fosroc or using equivalent approved product)

11.0 Micro Concrete

Mandatory Application Tools Dependent On Job Requirement

High pressure (min 150bars) water jetting machine.

Sand blasting.

Thermometer

Surface Spatula.

Drilling Machine

Angle Grinder

Mixing Paddle

Chipping Machine

Hand Held Mixing Machine/Pan Mixer

Roller/Brush

Hammer & Chisel

For smaller batch size slow speed stirrer with 300 to 400 rpm speed for mixing. For larger batch size, pan type mixer or tilting drum type mixer.



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Repairing With Form & Pour Micro-Concrete

11.1.1 Surface Preparation : Concrete

All surfaces must be clean and sound to ensure good adhesion

- Tap the concrete with hammer to locate areas of Delaminations
- All loose traces of concrete or mortar, dust, grease oil, etc. must be removed
- Saw cut the boundaries of the area to be repaired, perpendicular to the surface and remove the concrete within the saw cut boundary
- Damaged or contaminated concrete shall be removed to obtain a keyed surface by using hammer without damaging the embedded reinforcing steel.
- Non-impact/ vibrating cleaning methods, e.g. grit or high pressure water blasting can be adopted for better cleaning of the substrate
- The aggregate should be clearly visible on the surface of the concrete after preparation.

11.1.2 Surface Preparation : Reinforcement Steel

- Clean all exposed reinforcement to a minimum 10 to 15mm behind.
- Ensure back of rebar is also clean.
- Apply Zinc rich epoxy coating anti-rust coating for active corrosion control to both the new as well old steel reinforcement, ensuring that the reinforcing steel is completely coated with the product from all around.
- In case of corroded steel with upto 20% reduction in the steel dia due to corrosion, replace the corroded steel reinforcement with steel of same diameter.
- In case of rebaring, the rebar shall be grouted into the end concrete element using Epoxy grout, Masterflow 935 or equivalent.
- If partial length of the steel reinforcement is corroded, the same shall be cut and replaced with steel bar of same diameter and tied with steel wires at the opposite ends or welded to the existing steel reinforcement at the ends as per the recommendations.
- The tying / welding of rebar shall satisfy the minimum lap length criteria as specified by IS Codes as per the instruction of the Engineer-In-Charge.

11.1.3 Priming

To enhance bonding, the substrate can be primed with a bond coat of Epoxy resin based bonding agent or a cementitious slurry based bond coat modified with MasterEmaco SBR 2/ECO or MasterEmaco 131 or equivalent.

11.1.4 Formwork

- Shuttering moulds of plywood or steel formwork shall be used.
- In case of plywood, reuse of plywood more than 3 times shall be avoided.
- The Required formwork shall be properly measured, fabricated and kept ready for installation before the application of bond coat.
- Formwork should be sturdy, leak proof and should be strong enough to take the pressure of concrete and the weight and force of the vibration equipment till the concrete solidifies.



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- Proper supports to the formwork shall be provided to avoid displacement during the placement of the concrete and to avoid unwanted bulging using good quality props.
- After the concrete sets, formwork shall be removed carefully without damaging the concrete.
- To prevent sagging/cracking of the bulk green concrete, remove the formwork minimum after 24 hours of placement.

11.1.5 Mixing

It is strongly recommended that only full bags are mixed. Damaged or opened bags should not be used.

Only use clean potable water for mixing.

Water Powder Ratio: As per Manufacturer's specification.

Use slow speed electric drill fitted with a spiral paddle for 1-2 bags mixing. For larger batch size use a pan type mixer or tilting drum type mixer.

Place approximately 80% of the water in the mixer. Keeping the mixer running add material slowly. Add remaining water while continuing to mix. Mix for 3 – 4 minutes or until a lump free homogeneous consistency is achieved.

In hot weather conditions, pre-condition the material at 20 – 25.

Follow Manufacturer's specification for Mixing.

11.1.6 Placing

The minimum temperatures must be maintained during application and for at least 24 hours thereafter for optimum curing of the product.

The prepared substrate should be pre-soaked, preferably at least 2 hours before applying

The surface must be saturated dry, but without standing water.

Place material into the formwork within 20min. after mixing by pouring or pumping.

To prevent sagging/cracking of the bulk green concrete, remove the formwork minimum after 24 hours of placement.

11.1.7 Curing

As per the standard practice, the finished surface shall be cure for a minimum period of 3 days. It can be done by water ponding, water sprinkling or by wetting with Hessian cloths. Alternatively, where curing as per the standard practice is not feasible, a single coat of acrylic based curing compound can be used.

Microconcrete shall be (like MasterEmaco S346 of BASF/EMACO S46 T of BASF/SIKAREP MICROCRETE 2 of SIKKA / ShaliMortar M of STP/Polymer Mortar PX of Dr. Fixit or equivalent approved product)

12.0 Anti Carbonation Paint



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12.1.1 Material Requirements

All materials should be suitable for the intended application specific to the project.

Application Tools & Cleaning

Key equipment and tools need but not restricted to the below list depending upon job site requirement.

- High pressure water jetting machine.
- Hand held fractional HP electrical grinder with mountable tools such as, concrete wire buffing wheel, disk sander, etc. needed for mechanical removal of the laitance.
- Medium nap rollers, bristle brushes, wire brushes, etc.
- Tarpaulin sheet of sufficient dimensions to protect freshly coated areas from rain, with arrangement for tying it in position.

Concrete elements should be coated with Anti Carbonation Paint as per the following procedure

12.1.2 Methodology

1. Surface Preparation
2. Application Of Primer
3. Application Of Anti Carbonation Paint
4. Curing

12.1.3 Surface Preparation

- Concrete must be cured and minimum 14days old.
- Substrate shall not have a moisture level >4%.
- For exposed Concrete without existing coating: All loose traces of dust, dust, grease oil, form release agent etc. must be thoroughly removed mechanically by scrapping, brushing, high pressure water jetting.
- Blow holes, rough or irregular/rough substrate shall be made even. The weak cementitious slurry powder/ laitance on top of the concrete shall be suitably abraded & cleaned.
- Damaged or contaminated concrete shall be removed to obtain a keyed surface.
- ☐ For exposed Concrete with existing coating: Existing coating /its traces must be completely removed by suitable mechanical method to obtain a substrate suitable for coating application as above.

12.1.4 Application Of Primer

- Primer shall be homogenized first by stirring with a clean stick before application. Application can be by Hand (by roller or brush)- small quantities shall be transferred to a wider container for use, while keeping the lid of the supplied container closed.
Or
- By low pressure sprayer – can be directly sprayed from the supplied container or transferred to the sprayer container.



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- Ideally do not apply the material when either the temperature $>40^{\circ}\text{C}$ or humidity is $>75\%$.
- Allow Primer to dry for 2-3 hrs before the application of Anticarbonation Paint.

12.1.5 Precautions During Monsoon

- Application shall not be started if rain is imminent within 2h.
- Should it rain unexpectedly, substrate shall be allowed to dry before starting to coat.
- Should rain intervene during coating, application shall be stopped; after allowing substrate to dry, the area shall be recoated and continued to completion.
- Immediately after coating a segment (of size slightly smaller than the tarpaulin sheet), the coating shall be covered with tarpaulin until it dries ensuring that the tarpaulin is well tied down.
- Should a freshly coated area be exposed to rain before covering, the coated area shall be recoated after drying.

12.1.6 Application Of Anticarbonation Protective Coating

After the Primer is touch dry, Anticarbonation paint shall be applied to a Dry film thickness of 300μ in two coats as per the project needs.

- Stir Paint thoroughly before application till homogeneous mixture is achieved.
- Do not dilute the material.
- The prepared surface should be air dry before the application starts.
- Apply the material either by
- Hand (by roller or brush) - small quantities shall be transferred to a wider container for use, while keeping the lid of the supplied container closed.
- Application shall be in two coats, the second coat only after the first coat is dry to touch and at right angles to the first.

Or

- By airless spray equipment – can be directly sprayed from the supplied container or transferred to the sprayer container.
- The specified WFT of 650microns shall be applied in two coats of 325μ each after ascertaining through a trial patch it can be achieved. Do not apply the material when either the temperature $>40^{\circ}\text{C}/<5^{\circ}\text{C}$ or humidity is $>75\%$ or both.

12.1.7 Curing

Shall be done as per Manufacturer's Specifications.

12.1.8 Coverage

Shall be as per Manufacturer's Specification.

Product for Anti Carbonation painting shall be Masterprotect 300 of BASF or equivalent.

13.0 Reinforcement bar Priming for Corrosion Protection / Anti Rust Treatment

13.1.1 Priming of the exposed steel reinforcement bars shall take place immediately after the cleaning operation is complete and the bar is dry.



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13.1.2 Two continuous coating shall be applied to all exposed reinforcement bars using a suitable paint brush. Care shall be taken to ensure and achieve regular coating all around each bar. The minimum wet film thickness will be approximately 70 microns. The primer shall be allowed to dry for minimum 1 hour.

13.1.3 Priming shall be done with approved product (Zinc rich primer like CONCRESSIVE Zri of BASF/Friazinc R of SIKA/ShaliPrime ZnR of STP/Nitozinc Primer of Fosroc/Epoxy Zinc Primer of Dr. Fixit or equivalent approved product) as per manufacturer's specifications.

14.0 Concrete Priming/Bonding

14.1.1 The existing concrete surface shall be pre-soaked with a fine spray of clean water to make it dust free. If the concrete substrate is visibly dry or absorbent, water shall be sprayed again to make the surface wet before continuing. However, before priming, no free logged surface water shall be present.

14.1.2 For concrete repair having thickness ≤ 50 mm requiring use of thixotropic (sufficiently thick, non flowable to be applied by hand) mortar, the bonding shall be done using approved make Epoxy Resin based bonding coat (like CONCRESSIVE 1414 of BASF/ Sikadur 32 LP of SIKA/ShaliBond Concrete of STP/Epoxy Bonding Agent of Dr Fixit / Nitobond SBR of Fosroc or equivalent approved product) as Bonding Agent as per manufacturer's specification, applied to the existing surfaces for carrying out repair works, using suitable tools. Special care shall be taken to work the primer into all irregularities on the concrete surfaces.

(NOTE: As the Bonding Agent dries up quickly (having a short potlife) and application of the mortar/concrete may not be possible for a large area in a short time, Priming shall be done taking up small areas (from a large area) at a time. Mortar/Concrete has to be applied within stipulated time period as per manufacturer's specification.

14.1.3 If the primer dries before the mortar application, the area will be re-primed exactly as above.

14.1.4 For concrete repair having thickness ≥ 50 mm requiring use of forms and shutters, cement slurry modified with approved acrylic polymer (such as Rheomix 151 of BASF/Sika Top 77 of SIKA/Roff Hydamp of Dr. Fixit or equivalent approved product having solid content $\geq 40\%$) shall be used as bonding agent.

15.0 Anchor Fasteners

15.1 General Proper installation of the anchors is required to ensure satisfactory performance of the structure/equipment. Installers shall be trained in proper installation of concrete anchors. Concrete anchors have to be designed to restrain the structure/equipment against operating and seismic loads, including unbalanced loads that occur during normal operation. It is the intent of this specification that the anchors be installed in accordance with the manufacturer's requirements.

15.2 Responsibility



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The installation contractor is responsible for implementing this specification. Conflicts, if any, between this specification, manufacturer's installation requirements or other specifications of this project shall be brought to the attention of the Client/Consultant prior to the start of installation. The contractor shall submit an anchor installation procedure for the Client/Consultant's approval prior to installation. Provisions for QC inspection and documentation shall be included in this procedure.

15.3 Anchor Fastener Requirements

Locate and install anchor bolts in accordance with this specification and the installation drawings. A baseplate hole template shall be used to accurately drill all anchor bolt holes. The hole location tolerance shall be minimum specified of position marked on concrete floor. Holes shall be plumb to within 1° of vertical. Embedment depths shown in this specification are minimum depths for the equipment listed. Drill holes using approved equipment to ensure full design bond strength.

Typical threaded rod installation is shown in the attached drawing.

Quality Control inspection shall be documented to ensure the following:

- Materials conform to this specification.
- Holes are drilled with proper equipment thereby achieving proper diameter.
- Hole depth conforms to anchor manufacturer's requirements and this specification.
- Hole is cleaned.
- Rod is embedded to specified requirement. Nuts are preloaded to specified torque.
- Grout is mixed, placed, cured and tested per grout manufacturer's requirements.
- A Quality Assurance record sheet shall be filled out for each component and delivered to the Client/Consultant at the end of the project.

Anchor Fasteners shall be from HILTI or Equivalent conforming to required design parameters.



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SPECIFICATION FOR CIVIL WORKS

PART – III NORMS OF CEMENT CONSUMPTION

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GENERAL

For calculating the requirements of cement in various items of work the following standards will be adopted. Over the above theoretical quantity of cement, additional allowance upto plus or minus 3% shall also be allowed as certified by the engineer.

For items not covered in this standard, CPWD standards shall be followed or calculated as per uses/requirement in absence of standard norms. Cement required for enabling work and cement required for testing purposes will be taken into account for consumption purpose. However, in no case such quantity should exceed 5% of the total cement used in the work or as certified by the engineer based on actual observation whichever is less.

MASONRY WORK

Sl. No.	Description of Item	Cement Requirement
1.	Random rubble masonry with CM 1:4	1.255 quintals per cum
2.	Random rubble masonry with CM 1:6	0.825 quintal per cum
3.	Coursed rubble masonry in CM 1:6	0.75 quintal per cum
4.	Brick work in CM 1:4	0.950 quintal per cum of BW
5.	Brick work in CM 1:6	0.625 quintal per cum of BW
6.	Half brick work in CM 1:3	1.43 quintals per 10 sqm of area
7.	Half brick work in CM 1:4	1.06 quintals per 10 sqm of area
8.	75mm thick brick in CM 1:4	0.65 quintal per 10 sqm of area
9.	75mm thick brick in CM 1:3	0.81 quintal per 10 sqm of area
10.	P rejected brick bands, Drip course etc. in CM 1:6 finished with 12mm thick cement plaster	0.165 quintal per 10 RM
11.	Half brick thick, Honey combed brick work in CM 1:4	0.64 intals per sqm

PLAIN/REINFORCED CONCRETE

1	RCC/PCC of nominal mix 1:5:10 (excluding finishing with CP) complete	1.30 quintals per cum of concrete
2	RCC/PCC of nominal mix 1:4:8 (excluding finishing with CP) complete	1.70 quintals per cum of concrete
3	RCC/PCC of nominal mix 1:3:6 (excluding finishing with CP) complete	2.23 quintals per cum of concrete
4	RCC/PCC of nominal mix 1:2:4 (excluding finishing with CP) complete	3.18 quintals per cum of concrete
5	RCC/PCC of nominal mix 1:1.5:3 (excluding finishing with CP complete	4.00 quintals per cum of concrete
6	RCC/PCC of nominal mix 1:1:2 complete (excluding finishing with CP	6.10 quintals per cum of concrete



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Controlled Concrete - Plain and Reinforced		
7	Concrete grade (i) M -5A	To be mutually agreed based on mix design to be prepared by contractor & approved by the Engineer plus wastage and all incidentals as decided.
	(ii) M -5B	
	(iii) M -7.5A	
	(iv) M -7.5B	
8	Concrete grade (i) M -10A	
	(ii) M -10B	
	(ii) M -10B	
9	Concrete grade (i) M -15B	
	(ii) M -15C	
	(iii) M -15D	
10	Concrete grade (i) M -20B	
	(ii) M -20C	
	(iii) M -20D	
11	Concrete grade (i) M -25B	
	(ii) M -25C	
	(iii) M -25D	
12	Concrete grade (i) M -30C	
	(ii) M -30D	
13	Applying cement slurry on RCC slab for receiving cement concrete flooring.	2.75 kg/sqm
FINISHING		
1	6mm thick C.P. 1:4	0.280 quintal per 10 sqm area
2	10mm thick C.P. 1:5	0.370 quintal per 10 sqm area
3	10mm thick C.P. 1:4	0.430 quintal per 10 sqm area
4	10mm thick C.P. 1:6	0.300 quintal per 10 sqm area
5	12mm thick C.P. 1:3	0.734 quintal per 10 sqm area
6	12mm thick C.P. 1:4	0.547 quintal per 10 sqm area
7	12mm thick C.P. 1:6	0.360 quintal per 10 sqm area
8	15mm thick C.P. 1:4	0.655 quintal per 10 sqm area
9	15mm thick C.P. 1:6	0.440 quintal per 10 sqm area
10	20mm thick C.P. 1:4	0.850 quintal per 10 sqm area
11	20mm thick C.P. 1:6	0.560 quintal per 10 sqm area
12	12mm thick bearing plaster in CM 1:4 with neat cement finish	0.590 quintal per 10 sqm area
13	Neat cement punning	0.200 quintal per 10 sqm area
14	Flush or ruled or cut or weather pointing on brick work with CM 1:3	0.155 quintal per 10 sqm area
15	Flush or ruled or cut out or weather pointing on brick work with CM 1:2	0.200 quintal per 10 sqm area



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16	Raised&cut pointing on brick work with cement mortar 1:3	0.235 quintal per 10 sqm area
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17	Flush or ruled pointing on brick flooring with cement mortar 1:4	0.075 quintal per
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MISCELLANEOUS

1	Marble work for wall lining (Veneer work) 1.8 to 2.4 cm thick in CM 1:3 including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust)	0.715 quintal per (grey cement) 10 sqm of area 0.170 quintal per (white cement) 10 sqm of area
2	Marble work for wall lining (Veneer work) 4 cm thick in CM 1:3 including pointing with white cement mortar 1:2 (1 white cement : 2 marble dust)	1.020 quintal per (grey cement) 10 sqm of area 0.170 quintal per (white cement) 10 sqm of area
3	Grading roof for water proofing treatment with	
a)	CC 1:2:4 (1 cement : 2 coarse sand : 4 stone aggregate 20mm nominal size)	3.2 quintal per cum of Concrete
b)	CM 1:3	5.1 quintal per cum of mortar
c)	CM 1:4	3.8 quintal per cum of mortar
4	Providing and fixing MS fan clamps of standard shape and size in existing RCC slab including cutting chase and making good.	0.016 quintal each
5	Making plinth protection 50mm thick of CC 1:3:6 (1 cement : 3 sand : 6 graded stone aggregate 20mm nominal size) over 75mm bed of dry brick ballast 40mm nominal size well rammed and consolidated and grouted with fine sand including finishing the top smooth.	1.1 quintal per 10 sqm of area
6	Grouting with	
a)	CM 1:2	7.18 quintal per cum
b)	CM 1:3	5.40 quintal per cum
7	DPC 25mm thick (1:2:4)	0.81 quintal per 10 sqm of area
8	Making plinth protection with bricks on edge in CM 1:6 over 7.5cm bed of dry brick aggregate 40mm nominal size rammed, consolidated and grouted with fine sand and top of bricks pointed with CM 1:2.	0.86 quintal per 10 sqm of area
9	Providing and fixing 25mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.	0.05 quintal per 10 RM



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10	Providing and fixing 40mm dia GI pipe outlet in CM 1:3 including cutting and making good the walls.	0.075 quintal per 10 RM
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11	Providing chases 75mm wide 50mm deep in walls for conduit pipe and filling the same with CC 1:3:6	0.075 quintal per 10 RM
12	Fixing steel windows with 1:2:4 concrete blocks	0.40 quintal per 10 sqm of area
13	Cement-sand mortar :	
a)	1:1(1cement :1sand)	10.2 quintals per cum
b)	1:2(1cement : 2sand)	6.8 quintals per cum
c)	1:3(1cement : 3sand)	5.1 quintals per cum
d)	1:4(1cement : 4sand)	3.8 quintals per cum
e)	1:5(1cement : 5sand)	3.1 quintals per cum
f)	1:6(1cement : 6sand)	2.5 quintals per cum



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SPECIFICATION FOR CIVIL WORKS

PART – IV DIMENSIONAL TOLERANCE

GENERAL

The materials used in construction shall, besides conforming to the specifications and standards mentioned, be the best of the existing kinds obtainable. Where a particular 'Brand' or 'Make' of material is specified such 'Brand' or 'Make' of material alone shall be used.

A high standard of workmanship and accuracy shall be achieved in all sections and parts of the work. The workmanship shall be in accordance with the latest and the best civil engineering practice.

The Contractor shall ensure that all sections of the work are carried out with utmost care to achieve the dimensions shown in drawings or specifications. Where special and close tolerances are required in any particular section of work, these will be shown in the drawing and such tolerances shall be met. In the absence of such specific mention in drawings the following dimensional deviations may be tolerated, provided they do not impair the appearance or render the particular section of work unacceptable to the purpose for which it is intended. Tolerance for materials and workmanship not covered in this part as mentioned hereinafter will be in accordance with the relevant IS code.

Description	Permissible tolerance
Building bricks, in length width and height	: As per IS 1077 - 1992
Laterite stone, in length, width & height	: Plus or minus 5 mm
Natural building stone	
a) For stones required in ashlar masonry	:
Length & Breadth	: Plus or minus 5mm
Height	: Plus or minus 3mm
b) For stones required other than in ashlar masonry	:
Length & Breadth	: Plus 5mm, minus 10mm
Height	: Plus 5mm, minus 5mm
Concrete and reinforced concrete pipes : Length	: Plus or minus 1% of standard length
Internal diameter, upto 300 mm	: Plus 3 mm Minus 1.5 mm
Cast iron spigot & socket pipes and fittings	
Length of fittings	: Plus or minus 10mm



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Description	Permissible tolerance
Length of pipe	: Plus or minus 20mm
Thickness	: minus 1 mm
Internal dia of socket	: Plus or minus 3 mm
Depth of socket	: Plus or minus 10mm
External dia, upto 75 mm	: Plus or minus 3mm
100 mm	: Plus or minus 3.5mm
150 mm	: Plus or minus 4mm
Stoneware pipes, in length upto 75 cm	: Plus or minus 10mm
Upto 90 cm	: Plus or minus 15mm
In thickness of barrel and socket not exceeding 450mm :	Plus or minus 2mm
In thickness of barrel and socket between 500 to 600mm:	Plus or minus 3mm
Glazed tiles, length of all 4 sides	: Plus or minus 0.8mm
Individual dimensions and thickness	: Plus or minus 0.5 mm
Metal doors, windows and ventilators -	
In overall dimension	: Plus or minus 1.5 mm
Wooden doors, windows, ventilators Overall dimension	
of door, window, ventilators	: Plus or minus 3 mm
All components of shutter except glazing bar Width	: Plus or minus 3 mm
Thickness	: Plus or minus 1 mm
Glazing bar, width & thickness	: Plus or minus 1 mm
Mild steel tubes, tubulars and other wrought steel fittings	
a) Thickness	
i) butt welded light tubes	: Plus not limited minus 8%
medium and heavy tubes	: plus not limited minus 10%
ii) seamless tubes	: plus not limited minus 12.5%
b) Weight	



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- i) single tube (irrespective of the quantity) : + 10% , - 8%
- ii) for quantity of less than 150m of one size : + 10% , - 8%
- iii) for quantity of 150m and over of one size : + 4% , - 4%

Earth work

- Finished level of site levelling in hard rock : Plus or minus 50mm
- Finished level of site levelling except for hard rock : Plus or minus 100 mm
- Level of pits, trenches foundations : Plus or minus 50mm

Concrete & Reinforced concrete

- Footings, plan dimension : Plus 50 mm Minus 12 mm
- Eccentricity : 0.02 times the dimension of footing in the direction limited to 50 mm
- Thickness : Plus or minus 0.05 times the specified thickness

Foundations

- Deviation of planes and lines of their intersection from vertical or inclination along full height : Plus or minus 20 mm
- Deviation of horizontal plane from horizontal line for 1 m of the plane in any direction : Plus or minus 5mm
- for the whole plane : Plus or minus 20mm
- Sizes of cross section : Plus or minus 8mm
- Surfaces of inserts to support loads : Plus or minus 5mm
- Length of elements : Plus or minus 20 mm

Equipment foundations :

- Top level of bolt : Plus 20mm
- Top level of foundation before grouting : Minus 20mm
- Axes of anchor bolts in plan : Plus or minus 5mm
- Axis of foundation in either direction : Plus or minus 10mm



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Deviation in vertical line along height	:	Plus or minus 10mm
Sizes of pits in plan	:	Plus or minus 20 mm
Sizes of steps in plan	:	minus 20mm
Levels of steps, benches and pits	:	minus 20mm
Axes of inserts in plan	:	Plus or minus 10 mm
Basic dimensions in plan	:	Plus or minus 10mm
Deviation of horizontal plan from horizontal line		
for 1 m of plane in any direction	:	Plus or minus 5mm
for the whole plane	:	Plus or minus 20mm
Local deviations of top surface when checked		
with a 2 m long straight edge	:	Plus or minus 8mm
Buildings :		
Surfaces when checked with a 2 m long straight edge	:	Plus or minus 8mm
Sizes of cross section	:	Plus 8mm Minus 0 mm
Length of elements	:	Plus or minus 20mm
Deviation from horizontal plane, for whole building	:	Plus or minus 10mm
Plumb in verticality	:	1 in 1000 of height
for columns supporting floor beams	:	Plus or minus 10mm
for framed columns linked with crane girders and beams	:	Plus or minus 10mm
Reinforced concrete walls	:	Length : Plus or minus 20mm
Flatness of surface when checked with a 2 m		
long straight edge	:	Plus or minus 8mm
Level of top surface to support assembled elements	:	Plus or minus 5mm
Deviation in planes and lines of intersection from		
vertical	:	Plus or minus 15mm
Size of cross section	:	Plus or minus 8mm
Placing of reinforcement :		
Length of bar upto 75 cm long (Other than straight bars)	:	Plus 3 mm Minus 5 mm



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75 - 150 cm long	:	Plus 5 mm Minus 10 mm
150 - 250 cm long	:	Plus 6 mm Minus 15 mm

250 cm long and above	:	Plus 7 mm Minus 25 mm
Straight bars, all lengths	:	Plus or minus 25 mm
Spacing of bars	:	Plus or minus 5 mm

Anchor bolts :

Shift in location in plan	:	Plus or minus 5 mm
Same, when bolts are located outside of structural columns	:	Plus or minus 10mm
Top level	:	Plus 20 mm
Threaded length	:	Plus 30 mm

Masonry		For Walls	For Pillars
Width	:	Plus or minus 10 mm	Plus or minus 10 mm
Shift in axes	:	Plus or minus 10mm	---
Deviation in row from horizontal line for	:	Plus or minus 15mm	---
Flatness of surface when checked with a 2 m long straight edge	:	Plus or minus 10mm	Plus or minus 5 mm

Deviation in lines separating storeys

Deviation of surface from vertical and

at angles and corners	:	Plus or minus 15mm	Plus or minus 15 mm
for 1 storey	:	Plus or minus 10mm	Plus or minus 10 mm
for whole building	:	Plus or minus 30mm	Plus or minus 30 mm

Dimensions of openings for doors,

windows etc	:	Plus 15 mm
		Minus 0 mm

Flooring, skirting, dado and plastering :



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Insitu concrete floor	:	4 mm
Concrete tile and mosaic, in any 3 m length	:	3 mm
in large open area	:	15 mm
wall tiling - surface should not vary from general plane by more than 1 in 200. Marble and such superior work, in any 2 m length	:	1.5 mm
in any row	:	3 mm
Plastered surfaces, flatness when checked with a 2 m long straight edge	:	3 mm
Vertical surfaces, upto 1 storey	:	5 mm
Over full heights	:	10 mm
Metallic Inserts on assembled components length and width	:	Plus or minus 3 mm

Road work

The levels of the sub-grade and different pavement courses should not vary from those calculated with reference to the longitudinal and cross-sections of the road as shown on the drawing beyond the tolerance given below :-

Sub-grade	:	plus or minus 25mm
Sub-base	:	plus or minus 20mm
Base	:	plus or minus 15mm
Wearing course	:	plus or minus 6mm

SPECIFICATION FOR CIVIL WORKS

PART – V METHOD OF MEASUREMENT



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1.0	GENERAL
2.0	EARTHWORK
3.0	ANTI - TERMITE TREATMENT
4.0	CONCRETE (PLAIN & REINFORCED)
5.0	VOID
6.0	PLASTERING
7.0	VOID
8.0	FLOORING, PAVING & FACING WORKS

1.0 GENERAL



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1.1 The method of measurement of the various items of work shall be in accordance with IS : 1200 (Part 1 to 28) - 1971 to 1993 unless otherwise mentioned in this part or in the schedule of items or in preamble or in the specification.

1.2 If there is any contradiction in meaning between any portion of this part and that of IS : 1200 (Part 1 to 28) - 1971 to 1993, the stipulation of this part shall prevail.

1.3 The descriptions and explanations given herein have as much forces as though they are incorporated into the description of the items themselves in the schedule of items.

2.0 EARTH WORK & SAND FILLING

2.1 General

2.1.1 Each dimension upto 25 m shall be measured to nearest 0.01 m and to nearest 0.1 m for dimensions over 25 m. Areas shall be worked out to the nearest 0.01 m² and cubical contents to the nearest 0.01 m³.

2.1.2 Shoring and strutting shall not be measured separately unless otherwise specified.

2.1.3 Dewatering for earth work and sand filling work shall not be measured separately unless otherwise specified.

2.1.4 For classification of soils, relevant clauses of Technical specification (workmanship and other requirements) is to be followed.

2.2 Requirements for particular works

2.2.1 Site levelling

2.2.1.1 For site levelling levels shall be taken jointly before start & after completion of work and the quantity computed based on the levels. Measurements shall be made only for excavation and no separate measurement for filling shall be made except where earth, borrowed from elsewhere for site levelling work, will be measured separately only for that borrowed portion of earth.

2.2.1.2 In cases where it is not possible or convenient to take measurements from excavated cuts or borrow pits, excavation shall be worked out from filling based on the levels to be taken before and after completion of works. Deduction of 10 percent will be made for voids, however for consolidated fills done through heavy mechanical means, the deduction for voids shall be 5% in place of 10%.

2.2.1.3 In exceptional cases where the quantity is measured on the lorry measurement, loose stacks, boxes or any other similar method with the approval of the Engineer the deduction for voids shall be 20 per cent from the actual quantity.

2.2.2 Excavation

2.2.2.1 Before commencing excavation of foundations for buildings and structures, the initial ground levels shall be jointly recorded. The depth of excavation and the calculation of lift shall be based on this. Normally the initial ground level shall be considered as the level of



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the site as handed over to the contractor. In case excavation is planned and approved to be taken up subsequent to terracing, the terrace level shall be treated as initial ground level.

2.2.2.2 Excavation of foundations, trenches, basements, pits etc., shall be measured to the dimensions shown in the excavation plan, if any, or of the lowest concrete or masonry course, as the case may be and the actual depth. Working space and slopes shall not be measured.

2.2.2.3 Excavation of rock shall be measured from stacks of excavated rock with a deduction of 50 per cent for voids or measured in the solid based on levels.

2.2.2.4 In case of following works, no measurement will be recorded for the excavation beyond drawing / specification.

- (a) In work which will be covered externally with damp proof covering.
- (b) In work which requires formwork.
- (c) In work which requires workmen to operate from the outside and for guniting and post tensioned concrete, ground beams etc.

However, if there is a specific provision otherwise in the item/specification/preamble, for authorised working, it shall be measured accordingly. This working space may be 60 cm. measured from the face of the structure at lowest level, unless otherwise mentioned.

2.2.2.5 Surface Dressing

Trimming of natural ground, excavated surface and filled up area to remove vegetation and/or small in equalities not exceeding 15 cm deep shall be described as surface dressing and measured in square metres unless otherwise specified in the schedule of items/ preamble.

2.2.2.6 Lead

The distance for removal shall be measured over the shortest practicable route and not necessarily the route actually taken.

The description of the item shall include loading and unloading.

For the purpose of the measurement of the lead, the area excavated shall be divided in suitable block and for each block the distance from the centre of the block to the centre of the placed earth pertaining to this block shall be taken as lead.

2.2.3 Back filling/filling

2.2.3.1 In foundations, trenches, basements, pits, etc. and in other like areas, the measurements shall be the theoretical volume of the filling computed from drawings i.e. the volume measured under excavation minus the volume occupied by the structure and part filling if any, done otherwise.

2.2.3.2 In filling under floors the measurements shall be the theoretical volume as per drawings after deducting the part filling if any, done otherwise.



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2.2.3.3 In embankments, the work shall commence only after recording jointly the initial ground levels and the measurements shall be made on the basis of finished cross section and initial ground levels. Where controlled compaction by mechanical compaction is done, 5% deduction for voids shall be made. In case controlled compaction by mechanical means is not done then deduction for voids shall be 10%.

2.2.3.4 Filling/Back filling shall not be measured separately for items of excavation, where filling/back-filling is a part of the composite item and as such is included in excavation item itself.

3.0 Void

4.0 CONCRETE (PLAIN & REINFORCED)

4.1 Concrete

4.1.1 Dimensions shall be measured to nearest 0.01 m except for the thickness of slab, which will be to nearest 0.005 m. Areas shall be worked out to nearest 0.01 m² and cubic contents to nearest 0.01 m³.

4.1.2 The concrete shall be measured as per drawings except in the cases of approved variations which will be measured separately.

No deductions shall be made for the following :

- i) Ends of dissimilar materials such as beams, rafters, purlins etc., upto 500 cm² in cross section.
- ii) Openings upto 0.1 m² in area (In calculating area of an opening, the thickness of any separate lintel or sill shall be included in the height. No extra labour for forming such opening or voids shall be measured).
- iii) Volume occupied by reinforcement or other embedments such as anchors, inserts, conduits or volume occupied by pipes, sheathing etc. not exceeding 100 sq. cm. each in cross sectional area or as specified.
- iv) Small voids not exceeding 40 cm² each in cross section.
- v) Moulds, drip moulding, chamfer, splay, beds, grooves and rebates upto 10 cm in width or 15 cm in girth.

4.1.3 Columns shall be measured from top of column base to underside of first floor slab and from top of floor to underside of floor slab above thereafter. Beams shall be measured from face to face of columns and will include haunches. Depth of beam shall be measured from bottom of slab and in the case of inverted beams from top of slab. Chajjas and other cantilevers shall be measured from the face of the projection. Where vertical fins are combined with chajja, the latter shall be measured clear between fins. In case chajja is not combined with lintel, beam or slab, it shall be measured inclusive of bearing.

4.2 REINFORCEMENTS



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4.2.1 Norms for Steel Consumption

The requirement of mild and high strength deformed bars for various works like reinforcement, guard bars, fan hooks etc. shall be calculated as mentioned below :

i) As per drawing including

(a) Authorised laps, bends, standard hooks and deviations etc.

(b) Spacer bars, chairs, hangers, supports, spacer blocks dowels etc. are to be considered for wastage only and not to be measured for payment purpose.

ii) Quantity upto 0.5% of (i) above towards unaccounted wastages, plus

iii) Quantity upto 3% of (i) above towards cut pieces, which shall be pieces below 2m. length. These cut pieces shall not be taken back even though steel has been issued by the client/owner.

4.2.2 Reinforcements shall be measured in lengths to the nearest 0.01 m for various diameters of bar and converted into weight in tonnes to the nearest kg. on the basis of standard weights as per IS : 1786-1986. No allowance shall be made in the weight for rolling margin.

4.2.3 Authorised laps, standard hooks, bends shall be measured.

4.2.4 Sapacer bars, chairs, hangers, supports, spacer blocks and unauthorised laps etc. shall not be measured unless otherwise specified.

4.2.5 Dowels neither shown on the drawings nor instructed by the Engineer, but required for construction facilities shall not be measured for payment.

4.2.6 Modification of already embedded reinforcement, if required due to faulty fabrication or placement, shall not be measured for payment.

4.2.7 The measurements of reinforcements (including authorised laps, hooks, bends) shall be taken only from Bar bending lists or from the drawings except in the cases of approved variations which will be measured as per 4.2.2.

4.2.8 Wire netting and fabric reinforcement shall be described (including meshes and wire/strands) and measured in square metre, unless otherwise specified in the schedule of item. Authorised laps shall be measured. Raking or circular cutting and waste shall be included in the description of item.

4.2.9 Hoop iron shall be fully described and measured in running metres unless otherwise specified in the schedule of item.

4.2.10 Binding wire for the reinforcement shall not be measured separately and shall be included in the item of reinforcement.

4.3 ADMIXTURE



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Admixture will be measured separately as specified or on the basis of the requirement as approved by the Engineer.

4.4 FORMWORK

Each dimension shall be measured to the nearest 0.01 m and area to the nearest 0.01 sq.m.

4.4.1 Formwork shall be measured as the actual surface in contact with concrete and paid in sq.m. unless included in the rate for concrete in specific item of work.

4.4.2 All the measurements shall be computed from the drawings except in the cases of approved variations which will be measured separately.

4.4.3 Formwork shall not be measured separately for precast concrete work, grouting and damp proof course which shall be included in the concrete rates.

4.4.4 No measurement for formwork in construction joints shall be made.

4.4.5 Openings upto 0.1 sq.m. shall be neglected, as if non-existent, for the purpose of formwork measurement.

4.4.6 No extra measurement or payment shall be made for making the form work water proof or for supports, scaffolding, staging, centering, approaches etc.

4.4.7 No measurement shall be taken for the formwork in pockets, openings, chambers, chases etc., in concrete if the cross sectional area is less than or equal to 0.1 sq.m. in each case. If the cross section area of any opening exceeds 0.1 sq.m. the actual area of the formwork shall be measured for payment.

4.5 EMBEDDED PARTS

4.5.1 These shall be measured on the basis of standard theoretical weight of the complete insert according to the drawing/direction.

4.5.2 Embedded steel, which are the integral parts of the embedment according to drawing and are required for anchoring the embedded parts in concrete shall be measured on the basis of the theoretical standard weight. In case of anchor bolts the theoretical weights of the nuts, lock nuts, check nuts and washers shall be added in the measurement for payment.

4.5.3 All bye-works such as jigs, fixtures, templates and other arrangements which are not integral parts of the embedded parts, but necessary to secure those (embedded parts) in position shall not be measured for payment.

4.5.4 Anti-corrosive paint over the exposed surfaces and protection of the anchor bolts with grease tc., shall not be measured for payment.

4.5.5 Modification works necessary to rectify the mistake of already placed embedded parts shall not be measured.

4.6 GROUTING



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4.6.1 Grouting shall be measured in volume except in the cases of grouting by special cement compound or epoxy compound which will be measured by number.

4.6.2 Measurement shall be computed from the drawings except in the cases of approved variations which shall be measured separately and subsequently added to or deducted from.

4.6.3 Necessary formwork shall not be measured for payment.

4.7 Void

5.0 Void

6.0 PLASTERING & POINTING

6.1 All plastering and pointing shall be measured in sq.m. unless otherwise described. Dimensions shall be measured to nearest 0.01 m and areas to 0.1 sq.m.

6.2 Ceiling shall be measured between walls or partitions (dimensions before plastering) shall be taken. Measurement of wall plastering shall be taken between walls or partitions for length (dimension before plastering) and from top of floor or skirting to ceiling for height.

6.3 The methods of measurement including the deductions for openings etc., shall be according to the relevant part of IS : 1200 (Part 1 to 28) - 1971 to 1993.

SPECIFICATION FOR CIVIL WORKS

PART – VI SAFETY REQUIREMENTS FOR CONSTRUCTION WORKS

GENERAL

This specification deals with the subject matter of safety and protection to be observed in the Civil Construction. This shall be followed along with all related statutory requirements/obligation including Governmental byelaws, codes, ordinance of local or central authorities related to the construction work.



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In case of complicated work like deep excavation, intricate shuttering and formwork, excavation in loose soil and below water table, stacking of excavated earth etc., work plan with necessary drawings and documents have to be prepared by the Contractor and got approved by the Engineer.

Necessary reference shall be made to the following Indian Standard Codes on safety requirements for various type of work :

Indian Standard

4081 - 1986	Blasting & Drilling.
5916 - 1970	Construction with Hot Bituminous Materials
4130 - 1991	Demolition of Buildings.
3764 - 1992	Excavation Work
5121 - 1969	Piling & Other Deep Foundations.
4014 - (P-II) - 1967	Scaffolding, Steel Tubular.
3696 - (P-I & P-II) 1987 to 1991	Scaffolds and Ladders.
6922 - 1973	Structures Subject to Underground Blasts.
4756 - 1978	Tunneling Work.
5499 - 1969	Underground Air-raid Shelters in Natural Soil.
4138 - 1977	Working in Compressed Air.
7293 - 1974	Working with Construction Machinery
8989 - 1978	Erection of Concrete Framed Structures.

2.0 BLASTING

2.1 Detonators and other explosive for blasting shall be taken to the blasting area in the original container or any separate non-metal container. This shall not be carried loose or mixed with other materials. Detonators and explosives must be kept separately.

2.2 No shot for blasting shall be fired except by persons licensed to do so.

2.3 Drilling shall not be resumed after a blast has been fired unless a thorough examination has been made to make sure that there is no unexploded charge.

2.4 Before firing a shot, sufficient warnings by means of whistling and/or otherwise shall be given to get men off the danger area. Blasting areas shall be cordoned off & red flags during



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day time and red lights during night time displayed prominently marking off the cordoned area.

2.5 All people except those who have actually to light the fuses must be removed to a safe distance of not less than 200 metres as a rule.

2.6 Wherever possible, blasting mats should be used.

2.7 Contractors doing blasting work must have licence and an approved magazine to store explosives.

2.8 Blasting operations shall be carried out during fixed hours of the day which shall be notified in writing.

2.9 Provisions in explosives Rules 1940 as amended from time to time, Indian Explosives Act 1884 (IV of 1884), and others shall be strictly followed.

3.0 EXCAVATIONS

3.1 Sides of all excavations must be sloped to a safe angle, not steeper than the angle of repose of the particular soil. If it is not possible to give a proper slope, the sides of the excavation where there is a danger of fall or dislodgement of earth or any material, shall be securely supported by timber or other type of shoring.

3.2 No excavation or earth work below the foundation level of an adjoining building shall be taken up unless adequate steps are taken to prevent damage to the existing structure or fall of any part.

3.3 Every accessible part of an excavation, pit or opening in the ground into which there is a danger of persons falling shall be suitably fenced with a barrier upto a height of one metre suitably placed from the edge of the excavation as far as practicable.

3.4 No material or load shall be placed or stacked near the edge of the excavation or opening in the ground. The excavated material shall not be placed within 1.5 m of the trench or half of the depth of the trench whichever is more.

3.5 Cutting shall be done from top to bottom. No undercutting of sides of excavation shall be allowed.

3.6 All narrow trenches 1.2 m or more depth, shall at all times be supplied with atleast one ladder for each 30m in length or fraction thereof. Ladder shall be extended from bottom of the trench to atleast one metre above the surface of the ground. The side of the trenches which are 1.5 m or more in depth shall be stepped back to give suitable slope, or securely held by planking, strutting and bracing so as to avoid the danger of side collapse.

3.7 Materials shall not be dumped against existing walls or partition to a height that may endanger the stability of the walls.

3.8 While withdrawing piled materials like loose earth, crushed stone, sand, etc., from the stock piles, no over hanging shall be allowed to be formed in the existing dump.



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3.9 No material on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or public or any other agency at work.

4.0 DEMOLITION

4.1 On every demolition job, danger signs shall be conspicuously posted all round the structure and all doors, openings giving access to the structure shall be kept barricaded or marked except during the actual passage of workmen or equipment. However, provision shall be made for at least two independent exits for escape of workmen during any emergency.

4.2 During night, red lights shall be placed on or about all the barricades.

4.3 Where in any work of demolition it is imperative, because of danger existing to ensure that no unauthorised person shall enter the site of demolition outside working hours, a watchman should be employed. In addition to watching the site he shall also be responsible for maintaining all notices, lights and barricades.

4.4 All the necessary safety appliances as per IS :4130 shall be issued to the workers and their use explained. It shall be ensured that the workers are using all the safety appliances while at work.

4.5 The removal of a member may weaken the side wall of an adjoining structure and to prevent possible damage, these walls shall be supported until such time as permanent protection is provided. In case any danger is anticipated to the adjoining structure the same shall be got vacated to avoid any danger to human life.

4.6 The power on all electrical service lines shall be shut off and all such lines cut or disconnected at or outside the property line, before the demolition work is started. Prior to cutting of such lines the necessary approval shall be obtained from the electrical authorities concerned. The only exception will be any power line required for demolition work itself.

4.7 All gas, water, steam and other service lines shall be shut off and capped or otherwise controlled at or outside the building line, before demolition work is started.

4.8 All the mains and meters of the building shall be removed or protected from damage.

4.9 If a structure to be demolished has been partially wrecked by fire, explosion or other catastrophe, the walls and damaged roofs shall be shored or braced suitably.

4.10 Walkways and passage ways shall be provided for the use of the workman who shall be instructed to use them and all such walkways and passageways shall be kept adequately lighted, free from debris and other materials.

4.11 All nails in any kind of lumber shall be withdrawn, hammered or bent over as soon as such lumber is removed from the structure being demolished, and placed in piles for future cleaning or burning.



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4.12 All the roads and open area adjacent to the work site shall either be closed or suitably protected.

4.13 No electric cable or apparatus which is liable to be a source of danger or a cable or apparatus used by the operator shall remain electricity charged.

4.14 All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

5.0 VEHICLE

5.1 No person shall board any vehicle or equipment when it is in motion.

5.2 Suitable blocks shall be placed against the wheels of a vehicle when it is used for tipping materials into excavation or a pit or over the edge of any embankment or earthwork to avoid the danger of its running over the edge.

5.3 All workers shall stand clear of the vehicle while it is dumping. If the material being dumped is very heavy or sticky, dump hooks shall be used or dumper shall be clamped to prevent any danger of its tripping.

5.4 Materials shall not be allowed to be loaded in a vehicle so as to project horizontally beyond the sides of the body of the vehicle. All materials projecting beyond the front or rear shall be indicated by a red flag in the day and with red light in the night.

5.5 Driver of the truck or any heavy vehicle shall not reverse it unless assisted by a signal man who shall have a clear view of the driver and the area beyond the truck during reversing operation.

5.6 Maximum speed of a heavy vehicle must not exceed 15 km. per hour.

6.0 SCAFFOLDING, GANGWAYS, LADDERS & SHUTTERING

6.1 For all work that cannot be done from the ground level or from part of any permanent structure or from other available means of support, soundly constructed scaffoldings of adequate strength shall be used as a safe means of access to places of work.

6.2 All scaffolding shall be securely supported or suspended and wherever necessary be properly braced to ensure stability.

6.3 Chains, ropes or other lifting materials used for the suspension of scaffoldings must be of adequate strength and shall be of tested quality.

6.4 All such chains and ropes used for the suspension of scaffoldings shall be properly fastened to safe anchorage points.

6.5 The platform of a suspended scaffolding shall be sufficiently wide. Suspended scaffolding shall have hand rail on 3 sides of about 1.0 m height.



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6.6 All working platform and stages from which workers are liable to fall shall be of adequate width depending on the type of work done and closely boarded and planked.

6.7 Scaffolding or staging more than 3.5 m above the ground or floor, suspended from an overhead support or erected with stationary support shall have a guard rail properly attached, bolted, braced and otherwise secured atleast 1 m high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure. The platform shall also be provided with toe boards of atleast 150 mm high so placed as to prevent the fall of materials and tools from there.

6.8 All platforms or gangways, runways and the stairs shall be kept free from unnecessary obstructions, materials or junk.

6.9 Working platforms, gangways & stairways shall be so constructed that they shall not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.5 m above ground level or floor level they shall be closely boarded, shall be of adequate width and shall be suitably fenced.

6.10 Every opening in the floor of a building or in a working platform shall be provided with suitable fencing or railing whose minimum height shall be 1 m to prevent the fall of persons or materials.

6.11 Every ladder shall be securely fixed at top and bottom. A ladder more than 5 m long shall have a prop.

6.12 All ladders used shall be of good construction, sound materials and adequate strength. Ladders with defective or missing rungs shall not be brought into use. The spacing of rungs shall not exceed 30 cms and these shall be recessed atleast 12 mm into rails.

6.13 All ladders or rungs used for vertical height of more than 10 m shall have an intermediate landing. All such intermediate landings shall be provided with guard rails to a height of atleast 1 m.

6.14 Every ladder shall be securely placed so that it cannot move either at the top or at the bottom and it shall rise to a height of atleast 1.2 m above the place of landing.

6.15 No portable single ladder shall be over 8 m in length.

6.16 Spacing between the side rails of the ladder shall not be less than 300 mm for ladders upto 3 m in length. For longer lengths, this shall be increased at 6 mm for each additional 0.3 m of length.

6.17 Metal ladders must not be used for electrical work or near electric circuit of equipments.

6.18 All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use.



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6.19 Unfinished scaffolding which is under construction shall be prominently marked as unsafe and any access points shall be closed.

6.20 All Planking and Decking on walkways and scaffolds should be adequately supported at each end of the plank and intermediately if necessary. Planks should not be allowed to cantilever beyond the last support but should be overlapped if necessary on to the next plank.

6.21 Shuttering

The above remarks shall be applicable for this also. Shuttering, particularly for slabs, should be treated as a scaffold. Unfinished shuttering should be marked as dangerous similarly the finished formwork should be adequately supported, care being taken to avoid trap door effects.

7.0 MOBILE LIFTING APPLIANCES

7.1 No mobile lifting appliances shall be used on a sloping surface unless adequate precautions are taken to ensure stability.

7.2 Adequate precautions shall be taken to see that jib of the mobile crane does not come in contact with overhead electric transmission line.

7.3 Only one person shall give signals to the operator of mobile lifting appliances.

7.4 Maximum load to be lifted by lifting appliances shall be marked in a position where it can be clearly seen by the crane driver and the operator.

7.5 No load shall be raised, lowered or suspended from a chain or rope having a knot in any of the part.

7.6 No chain which is joined to another chain by means of bolt and nut shall be used for raising, lowering or suspending any load.

7.7 All chains, ropes and lifting gears shall be carefully examined and tested by a competent Maintenance Engineer at least once in every quarter.

7.8 When the work is stopped or when the mobile lifting equipment is not in operation, the boom must be lowered to the horizontal position and tied securely in place to prevent accidental drop.

7.9 No person shall walk under a load which is swinging by a lifting equipment.

Guide rope must be attached to the load to prevent its swinging.

7.10 The foot blocks of the crane before starting work shall be securely supported and firmly anchored to prevent its movement in any direction.

7.11 Use of Hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following standards of condition.

7.11.1 These shall be of good mechanical construction, sound material and adequate strength and free from defect and shall be kept in good working order.



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7.11.2 Every rope used in hoisting or lowering materials or as a means of suspension shall be of durable quality and adequate strength and free from patent defects.

7.11.3 Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in charge of any hoisting machine or give signals to the operator.

7.11.4 In case of every hoisting machine and every chain ring hook shackle swivel and pulley block used in hoisting or lowering or as means of suspension the safe working load shall be ascertained by adequate means, every hoisting machine and all gears referred to above shall be plainly marked with the safe working load. In case of hoisting machine having a variable safe working loading, each safe working load of the conditions under which it is applicable shall be clearly indicated. No part of any machine or of any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing. Mobile cranes shall have the working load and the radius of jib for the load marked on it.

7.11.5 The top pulley for hoisting a load shall be opened monthly and the spindle inspected to see if any undue wear has taken place and for greasing.

7.11.6 In case of departmental machine, the safe working load shall be notified by the Engineer concerned. As regards contractor's machines the Contractor shall notify the safe working load of the machine to the Engineer whenever he brings any machinery to site of work and get it verified by the Engineer concerned.

7.12 Motors, gearing, transmission, electric wiring and other dangerous part of hoisting appliances shall be provided with efficient safeguards. Hoisting appliances shall be provided with such means as will reduce to the minimum, the risk of accidental descent of the load. Adequate precautions shall be taken to reduce to the minimum, risk of any part of a suspended load becoming accidentally displaced.

8.0 RIVETTING, WELDING & GAS CUTTING & STEEL ERECTION

8.1 Rivetting

8.1.1 Bolts covered with wet or slippery compounds shall not be used in fabricating structural work.

8.1.2 The rivet heater must keep the rivet heating equipment as near as possible to the place of work.

8.1.3 A pail of water shall always be kept ready for quenching fire when stopping rivetting work.

8.1.4 Hot rivet shall not be thrown across aisles and shaftways.

8.1.5 Metal buckets for catching hot rivets must have false wooden bottoms to prevent rivets from rebounding.



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8.1.6 All rivets, bolts, nuts, and other tools must be kept in boxes and not left loose, (For any further safety measures relevant Indian Standards and safety specifications of structural section shall be referred to).

8.2 Welding & Gas Cutting

8.2.1 All cylinders must be used and stored in upright position only.

8.2.2 Cylinders must be stored away from open flames and other source of heat.

8.2.3 Oxygen cylinders must not be stored near other cylinders containing gas or oil, grease or other combustible materials.

8.2.4 While the cylinder is in use, the cylinder valve key or wrench must be placed on the valve spindle.

8.2.5 Before a cylinder is moved, the cylinder valve must be closed.

8.2.6 Gas cutting torches must be lighted by means of friction flames or similar other methods and not with matches.

8.2.7 When torches are being changed or welding stopped for some time valves for all cylinders must be closed.

8.2.8 The coloured lenses used for welding or gas cutting must be of proper shade for the work being done.

8.2.9 Suitable eye protection equipment such as goggles, hand shields etc., must be used by persons engaged in welding or gas cutting operations.

8.2.10 Before any heavy structural member is gas cut, make sure that it is cleared and supported by ropes, cables, chains or any other means to prevent its dropping or swinging.

8.2.11 Cylinder valves and connections are not to be lubricated. All oily or greasy substances must be kept away from cylinders. 8.2.12 Substantial and incombustible screen must be used below or near the welding operations, if there is a possibility of a spark falling on other workmen engaged in work closely.

8.2.13 All air pipe lines and air hoses must be frequently inspected. Air hoses shall not be used for dusting or for cooling purposes.

8.3 Steel Erection

8.3.1 All persons shall stand clear when a crane is sorting or shifting steel girders or other structural materials.

8.3.2 No person shall stand, walk or work beneath any suspended load.

8.3.3 Guide rope must be used for guiding lifting loads.

8.3.4 When guiding a beam or fabricated structure or erection it shall be so held that the employees hands do not get jammed against other objects.



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8.3.5 Safety belts equipped with suitable life lines must be used by persons working at heights and standing on structural members. Life line must be tied to an independent support. For any further safety measures, for Structural Steel Works, IS : 7205 - 1974 shall be referred to.

9.0 SAFETY APPLIANCES

9.1 Workers employed on mixing asphaltic materials, cement and lime mortars, shall be provided with protective footwear and protective goggles.

9.2 Those engaged in white washing and mixing or stacking of cement bags or any materials which is injurious to the eyes, shall be provided with protective goggles.

9.3 Those engaged in welding works shall be provided with welder's protective eye- shields.

9.4 Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

9.5 When workers are employed in sewers and manholes which are in use, the Contractor shall ensure that the manhole covers are opened and chambers are ventilated atleast for an hour before the workers are allowed to get into the manholes, and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public.

9.6 The Contractor shall not employ men below the age of 18 and women on the work of painting with products containing lead in any form. Whenever men above the age of 18 are employed on the work of lead painting the following precautions shall be taken

9.6.1 No paint containing lead or lead products shall be used except in the form of paste or ready made paint.

9.6.2 Suitable face mask should be supplied for use by them when paint is applied in the form of spray on a surface having lead paint dry rubbed and scraped.

9.6.3 Overalls shall be supplied by the Contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

9.7 The workers going into inspection chamber shall have gas masks, gum boots and rubber gloves while working inside. After coming out they shall have some disin- fectant from the first aid box for proper washing

9.8 All necessary personnel safety equipment such as safety helmets, safety boots, safety belts, leather gloves for welders, clear glass safety goggles etc., as considered adequate by the engineer have to be kept available for the use of persons employed at the site of work and maintained in condition suitable for immediate use and Contractor shall take steps to ensure proper use of equipment by the workers.



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9.9 All the persons entering the tunnel shall be provided with protective wear, such as helmets, steel toe safety shoe, gum boots or other suitable type of protective foot wear. In the case of steeply inclined tunnels and inshafts, safety belts shall also be provided.

9.10 Sign boards 1 x 1.5 m in size with the following wording shall be erected at the access to these areas. "CONSTRUCTION AREA, HELMET REQUIRED BEYOND THIS POINT"

9.11 No loose garments or ragged clothing shall be worn by the personnel engaged in tunneling operation.

9.12 A telephone system shall provided to ensure a positive and quick method of communication between all control location inside tunnel and portal of the tunnels when longer than 500 m and for shafts when longer than 50 m

9.13 Irrespective of length and bends in the tunnel, arrangements shall be made for transmitting of warning signals by any one of the following means.

9.13.1 By electrically operated bells, operated by battery/dry cells with the bell placed outside the tunnel and the position of the switch shifting with the progress of the tunneling work. The position of the operating switch although temporary shall be so chosen as to ensure proper accessibility and easy identification.

9.13.2 By the use of two field (magnet type) telephone.

9.13.3 Any other suitable arrangement like walkie-talkie.

9.14 Arrangement for rendering prompt and adequate first aid to the injured persons shall be maintained at every work site under the guidance of a medical officer-in charge of the project. Depending upon the magnitude of the work the availability of an ambulance at a very short notice (at telephone call) shall be ensured.

9.15 First-aid arrangements commensurate with the degree of hazard and with the number of workers employed shall be maintained in a readily accessible place throughout the working hours. At least one experienced first-aid attendant with his distinguishing badge shall be available on each shift to take care of injured persons. Arrangements shall be made for calling the medical officer, when such a need may arise. It is recommended that foreman/assistant foreman/supervisor/ permanent workmen who are normally present at each working phase in each shift are given adequate training on first-aid methods to avoid employment of a separate attendant.

9.16 Stretchers and other equipment necessary to remove injured persons shall be provided at every shift.

9.17 Where there are more than 50 persons working in a shift, effective artificial respiration arrangements shall be provided, with trained men capable of providing artificial respiration.

10.0 ELECTRICAL



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10.1 Only authorised persons shall handle or otherwise interfere with electrical equipment. Any person detecting electrical apparatus being handled by an unauthorised person or equipment in unsafe condition must report the matter to the Engineer concerned.

10.2 No person shall work on any live electric conductor or apparatus and no person shall assist such person on such work, unless he is authorised in that behalf.

10.2.1 After isolating the equipment from the source of supply before the work begins, a sign 'DONT'T SWITCH ON' must be hung on or near the switch to avoid its being accidentally or inadvertently switched on when persons are working.

10.2.2 Take out the fuses and keep in safe custody.

10.2.3 The switch may be locked if locking arrangement exists.

10.2.4 Earth the equipment, before work, to discharge it and short the terminals as a precautionary measure against accidental switching ON.

10.2.5 After the work is finished take out Earthing and shorting link.

10.2.6 Remove all tools and materials from the site of work. Replace the fuses and unlock the switch.

10.2.7 The switch shall only be put 'ON' by the person who switched it 'OFF' or by the person authorised by him in writing.

10.3 When working on live equipment use one hand only whenever possible, it is advisable to keep the other hand behind the back. Shocks from hand to hand are most dangerous.

10.4 All persons handling electrical gear in elevated position must use safety belts. Even a slight shock may cause loss of balance and fall. 10.5

No one shall attempt to extinguish a fire on or near a live electrical apparatus with water. Water is a good conductor of electricity. Use extinguishers wherever provided. Use sand and blankets etc., if available.

10.6 No person shall use any part of electrical equipment for storing or hanging clothes, umbrellas or other articles. Serious accidents occur from this practice.

10.7 For attending the work on O.H. lines or equipment use wooden ladders. Metallic ladders shall not be used.

10.8 Use insulated tools and ensure the insulation is in proper condition periodically at least once in three months. Use rubber gloves wherever possible.

10.9 As far as possible verbal instructions shall be avoided in case of pre-arranged shut- down of electrical apparatus.

10.10 When workers are employed for electrical installations which are already energised, insulating mats, wearing apparel such as gloves, sleeves and boots as may be necessary shall be provided. The workers shall not wear any rings, watches and carry keys or other materials which are good conductors of electricity.



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11.0 MISCELLANEOUS

11.1 The Contractor shall provide necessary fencing and lights to protect the public from accident.

11.2 Fire extinguishers adequate in number shall be kept by the Contractor at the site of works where there is risk of fire hazard.

11.3 Adequate washing facilities shall be provided near the place of work.

11.4 When the work is done near any place where there is risk of drowning, all necessary equipments shall be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provisions shall be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

11.5 These safety provisions shall be brought to the notice of all concerned by displaying on a Notice Board at a prominent place at the work spot. The persons responsible for compliance of the code shall be named therein by the Contractor.

11.6 To ensure effective enforcement of the rules and regulations relating to safety precautions, the arrangements made by the Contractor shall be open to inspection by the Engineer and Owner.

11.7 Notwithstanding the above clauses there is nothing in those to exempt the Contractor from the operations of any other Act or Rule in force in the Republic of India.

11.8 All storage, handling and use of flammable liquids shall be under the supervision of qualified persons. Flammable liquid shall not be stored inside the tunnel

11.9 All sources of ignition shall be prohibited in areas where flammable liquids are stored, handled and processed. Suitable warning and 'NO SMOKING' signs shall be posted in all such places. Receptacles containing flammable liquids shall be stacked in such a manner as to permit free passage of air between them.

11.10 All combustible materials shall be continuously removed from such areas where flammable liquids are stored, handled and processed. All spills of flammable liquids shall be cleared up immediately. Containers of flammable liquids shall be tightly capped.

12.0 REPORTING OF ACCIDENT

All accidents, major or minor must be reported immediately. The Contractor, will provide first aid to the injured person immediately and the injured person shall report to the first aid station along with the 'INJURED ON WORK' form duly filled in quintuplicate and submit to the Medical Officer of the First Aid Station".

Serious Injury

In case of serious injury, the following procedure shall be adopted by the Contractor :

1. Provide First Aid at his own First Aid Station.



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2. Take the injured person to the Hospital along with the "INJURED ON WORK" form duly filled in.
3. Reporting the accident to the Owner/Engineer by the Contractor.

Fatal Accident

Fatal accident must be reported immediately to the Engineer/Owner as well as to the Police.

Penalty

Failure to observe the Safety Rules will make the Contractor liable to penalty by way of suspension of work, fine and termination of contract.

ANNEXURE- A

LIST OF IS & IRC CODES REFERRED

List of IS codes referred in this document are indicated below however latest revisions of codes in use shall be followed.

IS 383 – 1970	Specification for coarse & fine aggregates from natural sources for concrete.
IS 2386 (Part 1 to 8) – 1963	Method of Test for aggregates for concrete
IS 456 – 2000	Code of practice for plain and reinforced concrete.
IS 712 - 1984	Specification for building limes.
IS 3182 – 1986	Specification for broken brick (burnt clay) fine aggregate for use in lime mortar.
IS 269 – 1989	Specification for 33 grade ordinary Portland Cement.
IS 455 – 1989	Code of practice for Portland Slag Cement.



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IS 1489 – 1991	Specification for Portland Pozzolana Cement.
IS 8041 – 1990	Specification for rapid hardening Portland Cement.
IS 8112 – 1989	Specification for 43 grade ordinary Portland Cement. IS
IS 12269 – 1987	Specification for 53 grade ordinary Portland Cement.
IS 8043 – 1991	Specification for Hydrophobic Portland Cement
IS 12330 – 1988	Specification for Sulphate resisting Portland Cement.
IS 6452 – 1989	Specification for high alumina cement for structural use
IS 8042 – 1989	Specification for White Portland Cement.
IS 3535 – 1986	Methods of sampling Hydraulic Cement.
IS 4031 (Part 1 to 15) - 1988 to 1991	Methods of test for Hydraulic Cement.
IS 4032 – 1985	Method of Chemical Analysis of Hydraulic Cement.
IS 2645 – 1975	Specification for Integral Cement Waterproofing Compounds.
IS 1599 – 1985	Method of Bend Test.
IS 1608 – 1972	Method of Tensile Testing of Steel Products.
IS 6925 – 1973	Method of test for determination of Water Soluble Chlorides in concrete admixtures.
IS 432 – 1982	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS 1786 – 1985	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS 1566 – 1982	Specification for hard drawn steel wire fabric for concrete reinforcement.
IS 280 – 1978	Mild steel wire for general engineering purposes.
IS 2062 – 1992	Structural steel (Standard Quality).
IS 1161 – 1979	Steel Tubes for Structural purposes.
IS 5624 – 1970	Foundation bolts.
IS 1363 - (Part 1 to 3) - 1992	Hexagon Head bolts, screws, nuts.
IS 2016 – 1967	Plain washers
IS 3063 – 1972	Single coil rectangular section spring washers
IS 1239 (Part 1&2)-1990	Mild Steel Tubes and other wrought steel pipe fittings.
IS 1367 – 1980	Technical supply conditions for threaded steel fasteners.
IS 1030 – 1989	Carbon steel castings.
IS 3480 – 1966	Flexible steel conduit for electrical wiring.
IS 2667 – 1988	Fittings for rigid steel conduits for electrical wiring.
IS 9537 (Part 3) – 1983	Conduit for electrical installations - Rigid Plain conduits of insulating material.
IS 6946 – 1973	Flexible non-metallic conduits for electrical installations.
IS 3419 – 1989	Fittings for rigid non-metallic conduits.
IS 5913 – 1989	Methods of tests for Asbestos Cement Products.
IS 2098 – 1964	Specification for asbestos cement building boards.
IS 2096 – 1992	Specification for asbestos cement flat sheets.
IS 9537 (Part 2) – 1981	Conduit for electrical installations - Rigid steel conduits.
IS 2614 – 1969	Method for sampling of fasteners.



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IS 1592 – 1989	Specification for asbestos cement pressure pipes
IS 9627 – 1980	Specification for asbestos cement pressure pipe (Light duty).
IS 6908 – 1991	Specification for asbestos cement pipes and fittings for sewerage and drainage.
IS 1626 (Part 1 to 3) - 1980 to 1991	Specification for asbestos cement building pipes & pipe fittings and roofing fittings
IS 459 – 1992	Specification for unreinforced corrugated and semi corrugated asbestos cement sheets
IS 1077 – 1992	Specification for common burnt clay building bricks.
IS 3495 (Part 1 to 4) -1992	Method of Test for burnt clay building bricks
IS 3620 – 1979	Specification for laterite stone block for masonry.
IS 1121- 1974	Method of test for determination of strength properties of natural building stone
IS 1124 – 1974	Method of test for determination of water absorption Sp. Gr. etc. of building stones
IS 1125 – 1974	Method of test for determination of weathering of natural building stones.
IS 1126 – 1974	Method of test for determination of durability of building stone.
IS 1127 – 1970	Recommendation for dimensions and workmanship of natural building stones for masonry work.
IS 2185 (Part-1)-1979	Specification for concrete masonry unit Hollow and solid concrete blocks
IS 2116 – 1980	Specification for sand for masonry mortar
IS 1542 – 1992	Specification for sand for plaster.
IS 2185 (Part-2)-1983	Specification for concrete masonry unit-Hollow and solid light weight concrete blocks.
IS 2185 (Part-3)-1984	Specification for concrete masonry unit - Auto claved Cellular Aerated concrete blocks.
IS 6041 – 1985	Code of practice for construction of Auto claved Cellular concrete block masonry.
IS 6441 (Part 1 to 9) - 1972 & 1973	Method of Test for Auto claved Concrete Products.
IS 3068 – 1986	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.
IS 2114 – 1984	Code of practice for laying in-situ terrazzo floor finish.
IS 460 (Part 1 to 3)-1985	Specification for Test Sieves.
IS 1237 – 1980	Specification for cement concrete flooring tiles.
IS 777 – 1988	Specification for glazed earthen ware wall tiles.
IS 1129 – 1972	Recommendation for dressing of natural building stone.
IS 1130 – 1969	Specification for Marble (blocks, slabs and tiles).
IS 809 – 1992	Specification for rubber flooring materials for general purposes.
IS 3462 – 1986	Specification for unbacked flexible PVC flooring.



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IS 3461 – 1980	Specification for PVC asbestos floor tiles
IS 2818 – 1990	Indian Hessians.
IS 653 – 1992	Linoleum sheets and tiles.
IS 5389 – 1969	Code of practice for laying hard wood parquet and wood block flooring.
IS 210 – 1978	Grey Iron Castings.
IS 2114 – 1984	Code of practice for laying in-situ terrazzo finish.
IS 1198 – 1982	Code of practice for laying of linoleum flooring.
IS 1003 (Part-2)-1983	Specification for timber panelled & glazed shutters, windows and ventilator shutters.
IS 1141 – 1973	Code of practice for seasoning of timber.
IS 1003 (Part-1) - 1983 & 1991	Specification for timber panelled & glazed shutters - Door shutters.
IS 287 – 1973	Recommendation for maximum permissible moisture content of timber used for different purposes.
IS 2202 (Part-1) - 1983 & 1991	Specification for wooden flush door shutters (Solid core type).
IS 2191 (Part-1&2)-1983	Specification for wooden flush door shutters (cellular and hollow core type).
IS 3087 – 1985	Specification for wood particle boards (Medium density) for general purposes.
IS 3478 – 1966	Specification for high density wood particle boards.
IS 3097 – 1980	Specification for veneered particle boards
IS 303 – 1989	Specification for plywood for general purposes.
IS 1328 – 1982	Specification for veneered decorative plywood.
IS 205 – 1992	Specification for non-ferrous metal butt hinges.
IS 1341 – 1992	Specification for steel butt hinges.
IS 362 – 1991	Specification for parliament hinges.
IS 453 – 1973	Specification for double acting spring hinges.
IS 3818 – 1992	Specification for continuous (Piano) hinges.
IS 206 – 1992	Specification for Tee and Strap hinges.
IS 281 – 1991	Specification for mild steel sliding door bolts for use with padlocks
IS 1019 – 1974	Specification for rim latches.
IS 2681 – 1979	Specification for non-ferrous metal sliding door bolts for use with padlocks.
IS 204 (Part 1&2)-1991&92	Specification for tower bolts - Ferrous and Non-ferrous metals.
IS 208 – 1987	Specification for door handles.
IS 2209 – 1976	Specification for mortice locks (vertical type).
IS 6607 – 1972	Specification for rebated mortice locks (vertical type).
IS 1823 – 1980	Specification for floor door stoppers.
IS 1837 – 1966	Specification for fan light pivots.
IS 207 – 1964	Gate and shutter hooks and eyes.



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IS 6343 – 1982	Specification of door closers (pneumatically regulated) for light door weighing upto 40 Kg.
IS 8756 – 1978	Specification for ball catches for use in wooden Almirah.
IS 6315 – 1992	Specification for floor springs (hydraulically regulated) for heavy doors
IS 7197 – 1974	Specification for Double action floor spring (without oil check) for heavy doors
IS 364 – 1993	Specification for fan light catch.
IS 3828 – 1966	Specification for ventilator chains.
IS 363 – 1976	Specification for hasp and staples.
IS 9899 – 1981	Specification for hat, coat and wardrobe hooks
IS 729 – 1979	Specification for drawer locks, cup-board locks and box locks.
IS 3564 – 1986	Specification for door closers (Hydraulically regulated).
IS 4351 – 1976	Specification for steel door frames.
IS 419 – 1967	Putty for use on window frames.
IS 5187 – 1972	Specification for flush bolts.
IS 3847 – 1992	Specification for mortice night latches.
IS 4621 – 1975	Specification for indicating bolts.
IS 1038 – 1983	Specification for steel doors, windows and ventilators.
IS 1977 – 1975	Structural steel (ordinary quality).
IS 1361 – 1978	Specification for steel windows for industrial buildings.
IS 7452 – 1990	Hot rolled steel sections for doors, windows and ventilators.
IS 1948 – 1961	Specification for aluminium doors, windows and ventilators.
IS 1148 – 1982	Specification for hot rolled rivet bars for structural purposes.
IS 1949 – 1961	Specification for aluminium windows for industrial buildings.
IS 204 (Part 1) – 1992	Specification for tower bolts-non-ferrous metal.
IS 733 – 1983	Wrought aluminium and aluminium alloy bars, rods and sections (for general engineering purposes).
IS 6248 – 1979	Specification for metal rolling shutters and rolling grills.
IS 1081 – 1960	Code of practice for fixing and glazing of metal doors, windows and ventilators.

IS 2339 – 1963	Specification for Aluminium Paint for general purpose in dual containers
IS 2835 – 1987	Flat Transparent sheet glass.
IS 5437 – 1969	Wired and figured glass.
IS 101 (Part 1 to 8) - 1964 to 1993	Method of sampling and test for paints, varnishes and related products.
IS 2074 – 1992	Ready mixed paint, air drying, red oxide zink chrome, priming.
IS 5410 – 1992	Cement paint, colour as required.
IS 427 – 1965	Distemper, dry, colour as required.



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IS 428 – 1969	Distemper, oil emulsion, colour as required.
IS 348 – 1968	French polish.
IS 5411 (Part 1&2) - 1972 to 1974	Plastic emulsion paint
IS 702 – 1988	Industrial Bitumen.
IS 73 – 1992	Paving Bitumen.
IS 217 – 1988	Cut Back Bitumen.
IS 454 – 1961	Specification for Digboi type cutback bitumen.
IS 5467 – 1986	Specification for shellac Wax.
IS 3384 – 1986	Specification for Bitumen primer for use in water proofing and damp proofing
IS 290 – 1961	Specification for Coal Tar Black Paint.
IS 341 – 1973	Specification for Black Japan, Type A, B & C.
IS 1322 – 1982	Specification for bitumen felts for water proofing and damp proofing.
IS 218 – 1983	Specification for creosote oil for use as wood preservative.
IS 3037 – 1986	Specification for Bitumen mastic for use in water proofing of roofs.
IS 1580 – 1991	Specification for Bituminous compound for water proofing and caulking purposes.
IS 8542 – 1977	Specification for polish for wooden furniture paste.
IS 9862 – 1981	Ready mixed paint, brushing etc.
IS 782 – 1978	Specification for caulking lead.
IS 405 (Part 1&2) – 1992	Lead sheet and strips.
IS 5134 – 1977	Bitumen impregnated paper.
IS 2849 – 1983	Specification for non load bearing gypsum partition blocks.
IS 8591 – 1977	Specification for floor polish paste.
IS 2095 – 1982	Specification for gypsum plaster boards.
IS 77 – 1976	Specification for linseed oil, boiled for paints.
IS 533 – 1973	Gum Spirit of turpentine (oil of Turpentine).
IS 1504 – 1974	Bees Wax.
IS 3536 – 1966	Ready mixed paint, brushing, wood primer pink.
IS 8273 – 1984	Specification for gypsum plaster for use in the manufacture of fibrous plaster board.

IS 5871 – 1987	Specification for bitumen mastic for tanking and damp proofing.
IS 651 – 1992	Specification for salt glazed stoneware pipe and fittings.
IS 1729 – 1979	Sand cast iron spigot and socket soil pipe.
IS 771 (Part 1 to 7) - 1979 to 1985	Specification for glazed fire clay appliances.
IS 1230 – 1979	Cast iron rain water pipes and fittings.
IS 774 – 1984	Flushing cisterns for water closets and urinals.



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IS 2548 (Part 1&2) – 1983	Specification for plastic seats and cover for water closet.
IS 1726 – 1991	Specification for cast iron manhole cover and frames.
IS 1239 (Part 1&2)-1990 to 1992	Mild steel Tubes and fittings.
IS 4984 – 1987	Specification for high density polyethylene pipes for potable water supplies: Sewerage and industrial effluents.
IS 2556 (Part 1 to 15) - 1972 to 1985	Specification for vitreous sanitary appliances (vitreous china).
IS 7328 – 1992	High density polyethylene materials
IS 4985 – 1988	Specification for unplasticised PVC pipes for potable water supplies.
IS 3076 – 1985	Specification for low density polyethylene pipe for potable water supplies.
IS 9762 – 1981	Specification for polyethylene floats for ball valve.
IS 3395 – 1984	Code of practice for fire safety of industrial buildings.
IS 7834 (Part 1 to 8) – 1987	Specification for injection moulded PVC fittings with solvent cement joint for water supplies.
IS 8008 (Part 1 to 7) – 1976	Specification for injection moulded HDPE fittings for potable water supplies.
IS 8360 (Part 1 to 3) - 1977	Specification for fabricated high density polyethylene fittings for potable water.
IS 784 – 1978	Specification for prestressed concrete pipe
IS 1703 – 1989	Specification for copper alloy float valves (horizontal plunger type) for water supply fittings.
IS 12234- 1988	Specification for plastic equilibrium float valve for cold water services.
IS 778 – 1984	Specification for copper alloy gate, globe and check valves for water works purposes.
IS 1536 – 1989	Centrifugally cast (spun) iron pressure pipes.
IS 1537 – 1976	Vertically cast iron pressure pipes for water, gas and sewage.
IS 1538 (Part 1 to 23) – 1976	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS 3589 – 1991	Electrically welded steel pipes for water, gas and sewage.
IS 781 – 1984	Specification for cast copper alloy screw down bib taps and stop valves for water services.

IS 1239 (Part 1&2) - 1990 to 1992	Mild steel tubes and fittings.
IS 779 – 1978	Specification for water meters.
IS 1795 – 1982	Specification for pillar taps for water supply purposes.
IS 1363 (Part 1 to 3) - 1992	Dimensions for screw thread run-outs and undercuts
IS 2016 – 1967	Plain washers.
IS 638 – 1979	Sheet rubber jointing and rubber insertion jointing.



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IS 4127 – 1983	Code of practice for laying of glazed stoneware pipes.
IS 458 – 1988	Specification for precast concrete pipes.
IRC 19 – 1981	Standard specification and code of practice for water Bound macadam.
IRC 29 – 1988	Tentative specification for 4 cm Asphaltic concrete surface course.
IRC 15 – 1981	Standard specification and code of practice for construction of concrete roads
IS 6313 – 1981	Code of practice for antitermite measures in building.
IS 1054 – 1962	Dieldrin emulsifiable concentrates.
IS 1308 – 1984	Aldrin dusting powders.
IS 6439 – 1978	Hepta chlor emulsifiable concentrates.
IS 2632 – 1964	Crotonaldehyde.
IS 1791 – 1985	Specification for batch type concrete mixers.
IS 10262- 1982	Recommended guidelines for concrete mix design.
IS 7861 (Part 1) – 1975	Code of practice for extreme weather concreting - Recommended practice for hot weather concreting.
IS 1199 – 1959	Methods of sampling and analysis for concrete.
IS 516 – 1959	Method of test for strength of concrete.
IS 7861 (Part 2) – 1981	Code of practice for extreme weather concreting. Recommended practice for cold weather concreting.
IS 2502 – 1963	Code of practice for bending and fixing of bars for concrete reinforcement.
IS 2751 – 1979	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
IS 800 – 1984	Code of practice for general construction in steel and deformed bars.
IS 816 – 1969	Code of practice for use of metal arc welding.
IS 814 – 1991	Covered electrodes for manual metal arc.
IS 3370 (Part 1&2)-1965	Code of practice for concrete structures for the storage of liquids.
IS 2911 (Part 1 to 4) – 1979 to 1985	Code of practice for design and construction of pile foundations.
IS 1343 – 1980	Code of practice for prestressed concrete.
IS 1785 (Part 1&2)-1983	Specification for plane hard drawn steel wires for prestressed concrete
IS 2250 – 1981	Code of practice for preparation and use of masonry mortars.
IS 1635 – 1992	Code of practice for field slaking of building lime.
IS 2212 – 1991	Code of practice for brick work.
IS 1597 (Part 1&2)-1992	Code of practice for construction of stone masonry.
IS 4101 (Part 1 to 3) - 1967 to 1985	Code of practice for external facing and veneer.
IS 737 – 1986	Wrought aluminium and aluminium alloys, sheet and strips (for general engineering purposes).



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IS 2572 – 1963	Code of practice for construction of hollow connect block masonry.
IS 1661 – 1972	Code of practice for application of cement finishes.
IS 5766 – 1970	Code of practice for laying of burnt clay brick flooring.
IS 5491 – 1969	Code of practice for laying of in-situ granolithic concrete flooring topping.
IS 3316 – 1974	Specification for structural granite.
IS 1196 – 1978	Code of practice for laying bitumen mastic flooring.
IS 1195 – 1978	Specification for bitumen mastic for flooring.
IS 3462 – 1986	Specification for unbacked flexible PVC flooring.
IS 1198 – 1982	Code of practice for laying fixing and maintenance of linoleum floor.
IS 848 – 1974	Specification for synthetic resin adhesive for plywood.
IS 4457 – 1982	Specification for ceramic unglazed vitreous acid resisting tiles.
IS 851 – 1978	Specification for synthetic resin adhesive for construction work (non structural) for wood.
IS 2202 (Part 1&2) - 1981 to 1991	Specification for wooden flush door shutters.
IS 102 – 1962	Ready mixed paint.
IS 1081 – 1960	Code of practice for fixing and glazing of metal doors.
IS 6248 – 1979	Specification for metal rolling shutters and rolling grills.
IS 1868 – 1982	Anodic coatings on aluminium and its alloys.
IS 2065 – 1983	Code of practice for water supply in buildings.
IS 2064 – 1993	Code of practice for selection, installation and maintenance of sanitary appliances.
IS 7634 (Part 1 to 3) – 1975	Code of practice for plastic pipes.
IS 1742 – 1983	Code of practice for building drainage.
IS 5330 – 1984	Criteria for design of anchor blocks for penstocks with expansion joints.
IS 3114 – 1985	Code of practice for laying of cast iron pipes.
IS 783 – 1985	Code of practice for laying of concrete pipes.
IRC-SP11- 1977	Hand book of quality control for construction of roads and run- ways.
IRC-63 – 1976	Tentative guidelines for use of low grade aggregates and soil aggregate mixtures in road pavement construction.
IRC-60 – 1976	Tentative guidelines for use of Lime Fly Ash Concrete as pavement base or sub-base.
IRC-74 – 1979	Tentative guidelines for use of Lean Cement Concrete and lean concrete Fly Ash Concrete as pavement base or sub-base.
IS 6509 – 1985	Code of practice for installation of joints in concrete pavement.
IS 1838 (Part 1) – 1983	Specification for performed filler for expansion joint in concrete



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	pavements and structures.
IRC-43 – 1972	Recommended practice for Tools, Equipment and appliances for concrete pavement construction
IRC-15 – 1970	Standard specifications and code of practice for construction of concrete road.
IS 3036 – 1992	Code of practice for laying lime concrete for a water proofed roof finish.
IS 1346 – 1991	Code of practice for water proofing of roofs with bitumen felts.
IS 1609 – 1991	Code of practice for laying damp proofing treatment using bitumen felt.
IS 4365 – 1967	Code of practice for application of bitumen mastic for waterproofing of roofs.
IS 9103 – 1979	Specification for admixtures for concrete.
IS 2645 – 1975	Specification for integral cement water proofing compounds.
IS 1834 – 1984	Specification for hot applied sealing compound for joint in concrete.
IS 278 – 1978	Specification for Galvanized barbed wire for fencing.
IS 2721 – 1979	Specification for Galvanized steel chain link fabric.
IS 280 – 1978	Specification for Mild steel wire.
IS 4826 – 1979:	Specification for hot dipped galvanized coating on round steel wires
IS 1200 (Part 1 to 28) - 1971 to 1993	Method of measurement of building and Civil Engineering Works.
IS 4081 – 1986	Safety code for blasting.
IS 5916 – 1970	Specification for cast iron gratings for drainage purposes.
IS 4130 – 1991	Safety Code for demolition of building.
IS 3764 – 1992	Safety code for excavation work.
IS 5121 – 1969	Safety code for piling.
IS 4014 (Part 2) – 1967	Code of practice for steel tubular scaffolding.
IS 3696 (Part 1&2) - 1987 to 1991	Safety code of scaffolds and ladders.
IS 6922 – 1973	Criteria for safety and design of structures subject to underground blast
IS 5499 – 1969	Code of practice for construction of underground raid shelter.
IS 4138 – 1977	Safety code for working in compressed air.
IS 7293 – 1974	Safety code for working with construction machinery.
IS 8989 – 1978	Safety code for erection of concrete framed structures.
IS 4756 – 1978	Safety code for Tunneling work.
IS 7205 – 1974	Safety code for erection of structural steel works.