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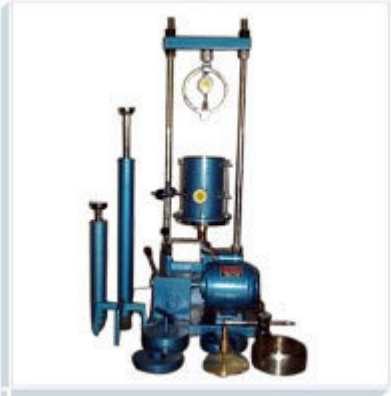
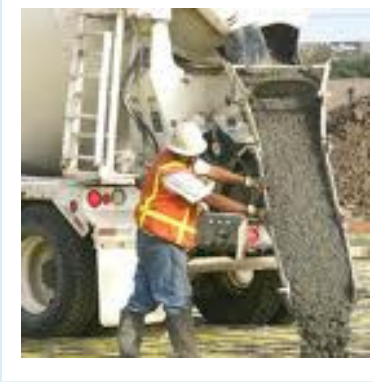
READY RECKONER

FOR

BETTER CIVIL

CONSTRUCTION PRACTICES





GUJARAT ENGINEERING RESEARCH INSTITUTE

(ISO 9001-2008 Institute)

VADODARA

Narmada, Water Resources ,
Water Supply & Kalpasar Department
2010

CONTENTS

PREFACE

PREFACE

GERI has done quite a huge work of testing as well as research in the field of Civil Engineering, especially soil and construction material in past. Many a times it has been experienced that there is a dire need for some type of Ready Reckoner or Manual which comes handy to use for field staff engaged in civil construction.

In the past, in 2002 GERI had come up with 'Guidelines For Quality Control And Quality Assurance'. Since then these guidelines has been of immense use and has served its very purpose for quality references for field and laboratory staff.

Keeping in view and making pace with the innovative technology of recent era, it is a need of the hour to have more updated, informative and self contained guidelines to be used for civil construction practices.

In light of that GERI has now come up with complete guidelines in the form of Volume , named **' Ready Reckoner For Better Civil Construction Practices '**.

This volume is complete in itself with special stress on various civil construction related tests to be performed on field and in laboratories by being within the norms prescribed by BIS and ASTM.

Special attention is given on following aspects while preparing this volume.

- Latest revisions of BIS are adopted, with mentioning latest reaffirmation years till 2010.
- BIS standards which had been earlier active, later became inactive are highlighted.
- Chapter on Quality Assurance is added.
- More handy, user friendly and trendy format is adopted.

In case of any suggestion, modifications please feel free to contact GERI through e-mail: geribrd@rediffmail.com. The necessary corrections will be made in the manual. Soft copy of the same is also placed on our website www.gerionline.org.[1]

We hope this manual will play an important role in quality improvement as well as quality assurance in the time to come.

` U K Sarvaiya
Chief Engineer and Director
GERI, Vadodara

[1] Official Web Site of GERI

Part I
SOIL

EARTH WORK

1.0 GENERAL

Earthwork is required for earth dam, road embankments, bridge approaches, canal embankments, C. O. T, filling behind retaining walls etc. Different zones of embankments require soils with different properties. All these call for similar construction techniques and hence similar quality control. General activities carried out for earthwork are given below.

- Selection of borrow area and excavations to the required limiting depth or as per site conditions.
- Laboratory testing of various soil sample available from excavation and / or borrow areas.
- Suitability decision for specific application.
- Determinations of Natural Moisture Content (NMC) of borrow areas material.
- Determination of Proctor Density values i.e. Maximum Dry Density (MDD), Optimum Moisture Content (OMC).
- Determination of moisture to be added to account for Natural Moisture Content (NMC), Optimum moisture Content (OMC) and construction needs.
- Preparation of seat of embankment after removal of vegetation roots and other organic materials by stripping to the required depth.
- Determination of type of soil and testing for its properties.
- Field test for compaction of filter or necessary test for rubble/rock toe as the case may be
- Placing of uniform layers of specified thickness of soils for embankment.
- Watering and compaction.
- Checking Field Dry Density (FDD) and Field Moisture Content (FMC) and degree of compaction.
- Preparation of daily and monthly reports on results of compaction.

2.0 BORROW AREA INVESTIGATIONS

Construction of embankment involves utilization of natural material, viz., Soils. Required soil is taken from borrow area and/or cuttings of excavations. This soil, before using in construction requires suitability testing for design of particular embankment. This needs borrow area investigations. The program of borrow area investigation should be decided in consultation with Central Design Organization & GERI.

Borrow area investigations consist of following major parts, Viz.,

- Collection of samples (Table-1),
- Field tests and visual examination of soils (Table -2),
- Laboratory testing for suitability of material at required frequency (Table -3).

Table- 1 shows brief details of sampling methods. Suitable method/methods, as per site condition and soil type or for any other requirement, may be adopted.

Table – 2, shows simple field identification tests which are required to be performed on field. These tests can be performed as and when required.

Table – 3, gives details of different soil tests which can be performed as per requirements.

2.1 Laboratory Testing:

Soil samples collected from the borrow area are tested for different properties. The main physical and engineering properties are listed below.

1. Determination of water content (moisture content).
2. Specific gravity.
3. Grain size analysis.
4. Atterberg's limits (LL, PL, PI).
5. Density moisture relationship (light), Standard Proctor Density.
6. Density moisture relationship (heavy), Modified Proctor Density.
7. Shear strength properties.
8. Density Index (Relative density) for granular soils.
9. Permeability.

In addition to these properties, determination of consolidation characteristics, swell pressure, and swelling index etc. are required for certain soils.

The list of relevant Indian Standards is given at Table-4.

Quantity of the soil sample required for various tests is given at Table -5.

3.0 EMBANKMENT CONSTRUCTION

Embankment construction can be defined as laterally unsupported fills built on the natural ground surface. Embankments are of two types.

Homogeneous Embankment: This consists of practically uniform quality of material in embankment. There is no designed plan of material distribution in the body of embankment in the form of zones. IS: 8826:1978, defines It as "An earth dam composed of single type of material"

Zoned Embankment This consists of an embankment dam composed of zones of different types of soil. (IS: 12169 : 1987) A zoned embankment is rolled filled embankment which consists essentially of an inner or impervious section supported by two or more sections of relatively pervious materials. Cut off trench (COT) is worth mentioning.

A foundation cut off trench of moderately impervious material should be provided under the embankment. The bottom of the COT should be wide enough to accommodate excavation, backfill and compaction equipment. The trench's minimum width and depth should be 4 feet and the side slopes should be no steeper than 1H : V.

(A) Earth from Excavation of COT under Dam Embankment.

- Suitable material obtained from the excavation of COT shall be used, either immediately or after stock piling and re handling.
- The suitability of the material to be used in the various zones of the embankments shall be ascertained after laboratory tests.
- Unused stuff shall be disposed properly so as not marring the appearance of structure.
- The earth obtained from the excavation from COT shall be treated at par with the earth to be obtained from borrow pits and similar degree of control shall be exercised.

(B) Earth from Borrow Area Excavation.

- Quarry map should be invariably made the part of the tender for the guidance.
- All the earth which shall be required for the constructions of various zones, like shell and core and which is not available from the exaction of COT shall be obtained from the designated borrow areas.
- Borrow areas shall be in no case closer to the toe of dam and shall have shallow depth when located in sequence closer to the toe of dam.
- The type of equipments used and the operations in the excavation of earth in the borrow areas shall be such, so as to produce the uniformity of mixture of earth/material to be used for embankment.
- In case when borrow areas are designated on the reservoir / water side of the dam, the location of borrow areas should be reasonably away from the upstream toe of the dam.

(i) General Points to be Observed before Zoned Embankment is Constructed.

- Sources of material suitable for different zones should be properly demarcated.
- Flow charts should be prepared, showing borrow areas along with quantity of material available for different zones.
- Excavated material available and suitable for embankment for different zones should be tested and stacked separately.
- Advance planning is required so that whenever need arises excavated material is directly utilized in respective zone of embankment.

Various tests carried out as per relevant IS for investigation, design as well as quality control are detailed in Table-4.

(ii) Preparation of embankment

- Strip off all trees, shrubs, jungle growth, roots, top soil containing small or large roots, organic matter etc.
- Remove deep roots of trees at least up to one-meter depth below the ground surface.
- Scarify the stripped surface to a depth of 100 mm to 200 mm.
- Break the clods before spreading any material over surface.
- Any ridges or mounds should be stepped so as to provide a close bond between new and old work.

(iii) Laying

- All the acceptable material free from organic matter, is to be laid or placed in the embankment in 15 to 25 cm (loose) layers as per IS : 4701: 1982 (Reaffirmed 2009) or as specified.
- The laying is to be done for full width of the embankment and section is built up regularly in layers, in accordance with the designed embankment section, with provision for dressing the shoulders or plods.
- All clods are broken at the borrow pits. Remaining small clods are broken before compaction is commenced on the embankment section.
- The surface is graded at all the times and crowned in center so that during rains, water is carried away rapidly to the edges and down the slope of the fill.
- For the zoned embankments, the change over from one material to another is made and compacted with some allowance beyond the critical line of contact.
- In case the whole length is not taken up for laying at a stretch, the end edges of embankment are provided with steps in an overall slope of 1 in 5 to permit satisfactory contact with the length of embankment to be taken up.

(iv) Compaction

- The dry density and the optimum moisture content at which the material needs to be compacted are predetermined in the laboratory.
- Compaction is achieved by using appropriate rollers and maintaining necessary bed thickness of each layer.
- Proper care is to be taken to see that required compaction is achieved around embedded instruments.
- While compacting back fill material along abutment contacts or adjacent to cut-off walls and rigid parts of any structure, care is to be taken to achieve intimate contact. Such surfaces are thoroughly cleared prior to placing the material. In general, clayey material as available is used at these locations to avoid seepage through the contact faces.

(v) Moisture control

Materials are conditioned to the desired moisture content at the site of excavation or embankment by surface inundation of the borrow pits prior to excavation by ponding or by sprinkling water on embankment under construction.

(vi) Field control

It is necessary to establish a field laboratory to carry out requisite tests at field, while compaction operations are in progress. The lab provides a continuous approximation of materials used and compaction attained. Following field tests are carried out.

(1) Field moisture content test.
(2) Density tests for both cohesive and non-cohesive material.
(3) Optimum moisture content test.

TABLE 3 (Field Test) indicates the relevant IS and other relevant details for the testing.
Penetrometer test provides a quick guide for field compaction control. Equipment like moisture and density gauge is deployed to indicate such appraisal quickly.
A complete record is kept for all the tests made and compared carefully with the laid down standard. Any Deficiency can be made good by suitably adjusting the moisture content and number of passes of the roller. The density determination tests are done in following cases.

(i) In area where degree of compaction is doubtful,
(ii) In area where embankment operations are concentrated,
(iii) For every 300 m^3 of embankment where compaction is doubtful in isolated areas,
(iv) For representative tests for every 4500 m^3 of earth fill, and
(v) For record tests at location of all embedded instruments.

As general guidelines for field staff, specific “DO’S” and “DON’TS" are given in Table 6, for exercising quality control. For rapid check, O. K. Card shown in Table 7 is used. The list of records to be maintained and format of maintaining daily test report are detailed in Table 8 and 9 respectively.

(vii)Filter Materials

Filter is required to prevent migration of soil particles with water as well as to allow the water to safely pass without building of excessive pore water pressure. Following aspects are taken care, to form a good filter.

- Layer of finer filter material is placed next to the earthwork in IP zone, as well as on the foundation, this is followed by progressively coarser layer of filter to form a graded filter.
- The filter material is laid in layers of not exceeding 15 cm thickness or as specified.
- The gradation curve of filter is kept nearly parallel to that of the base material.
- Filter material is clean, sound, well graded and free of debris, silt and clay.
- The finer filter material consists of sand passing 2 mm sieve.
- Laying of filter material is done side by side with casing and hearting materials
- It is saturated with water and properly rolled.
- Mixing of filter material with adjoining soil is avoided.
- No segregation is allowed.
- Density is fulfilled as minimum of 70% RD or as specified.

Filter between casing and core material or between two consecutive casing materials (If more than one casing material is used) should have following filter criteria.

$$(a)\frac{D_{15(f)}}{D_{15(b)}} \rangle 4 and \langle 20$$

$$(b)\frac{D_{50(f)}}{D_{50(b)}} \langle 25$$

$$(c)\frac{D_{15(f)}}{D_{85(b)}} \langle 5$$

Where (f) indicate filter material or the material on d/s side in the direction of seepage and (b) indicates base or u/s material.

As an alternative to graded filter, non-woven geo fabrics can also be adopted.

TABLE 1

SAMPLING METHODS

1.0 Samples are of Two Types:

1) Disturbed Samples & Undisturbed Samples.

Disturbed Samples

These are taken by methods which modify or destroy the natural structure of the material; though with suitable precautions the natural moisture content can be preserved.

Disturbed soil samples are collected as below:

A	**From Trial Pits:**
	From individual stratum by cutting a notch in the side.
B	**From Bore Holes:** The methods are by
B-1	**Auger Boring :**
	An auger may be used for boring holes to a depth of about 6 m in soft soil.
B-2	**Split Spoon Sampler:**
	Split spoon sampler is a modified form of the open tube sampler in which the sampling tube is split in to two halves held together by the cutting edge and the sampler head. The split spoon sampler driven as specified in IS: 2131-1963 (Reaffirmed 2007) , may be used in foundation investigation to collect samples for visual identification and preliminary laboratory tests.
B-3	**Wash Boring:**
	In this method, water is forced under pressure through an inner tube, which may be rotated or moved up and down inside a casing pipe. The lower end of the tube, fixed with sharp edge or a tool, cuts the soil which will be floated up through the casing pipe around the tube. The slurry flowing out gives an indication of the soil type.

Undisturbed Samples

These are taken by methods which preserve the structure and properties of the material

Undisturbed samples are collected as below:

A	**From trial pits:** The methods are by
A-1	**Chunk Sample:**
	A block of clay should be carefully removed with a sharp knife taking care that no water is allowed to come in to contact with the sample and that the sample is protected from exposure to direct sun and wind. The chunk sample should be coated with molten wax so that the layer of wax prevents escape of moisture from the sample.
A-2	**Core Cutter :**
	Core cutter method(IS:2720(Part–XXIX) -1975(Reaffirmed 2010) is used to determination of dry density of soil in place. The in place density of soil is needed for stability analysis for the determination of the degree of compaction of compacted soil, etc. The core – cutter method is suitable for fine grained soils free from aggregations.
B	**From Bore Holes**: The methods are by
B - 1	**Shelby Tubes:**
	Undisturbed sample is collected by thin walled Shelby tube from bore hole. The Shelby tube used for sampling should be of smooth surface and appropriate area ratio and cutting edge angle as required in IS: 1892 of 1962 thereby minimizing disturbance of soil during sampling.
B - 2	**Piston Sampler:**
	A piston sampler consists of two separate parts, (a) the sample cylinder & (b) the piston system; the latter which is actuated separately, fits tightly in the sampler cylinder. The single important control in the operation of the piston sampler is the separate actuation of the piston system. It may be done by separate drilling rods or by a liquid pressure device or by a special rock and wire rope system.

Note : When it is not possible to collect undisturbed samples in cohesion less soils, the following tests are conducted in addition to testing of disturbed samples, if required, to assess in situ status of the soil.

1. Dry density in place at accessible locations by
   - Sand replacement method (IS : 2720 (Part XXVIII) – 1974
   - Water replacement method (IS : 2720 (Part XXXIII) – 1971
2. Standard penetration tests in bore holes (IS : 2131-1981)
3. Static cone penetration tests in bore holes (IS: 4968 (Part III) – 1976)
4. Dynamic cone penetration tests in bore holes (IS: 4968 (Part I & II) – 1976)
5. Pressure meter tests in bore hole.
6. Plate load test (IS: 1888 – 1982)

TABLE 2

SIMPLE FIELD-TESTS FOR IDENTIFICATION OF SOILS

Sr. No.	Field Test or Visual Examination	Procedure
(a)	Shaking or dilatancy test	Take a small representative soil sample to form a pat of size of about 5 cm^3 by addition of adequate quantity of water to nearly saturate it, mix thoroughly and place the soil pat in open palm of one hand and shake horizontally, striking vigorously against the other hand several times. Squeeze the pat between the fingers. The appearance and disappearance of the water with shaking and squeezing is referred to as reaction. This reaction is called, • Quick , if water appears and disappears rapidly; • Slow , if water appears and disappears slowly. • No reaction, if the water condition does not appear to change. Observe and report type of reaction as descriptive information. • Fine clean sands react quickly & distinctly. • Very fine-grained cohesion less soils like silt and rock flour react somewhat slowly than fine sands. • Plastic clays do not react to this. • Cohesionless soils when moist do not stain the hands when rubbed.
(b)	Surface tests	Cohesive soils are identified by rubbing a small ball or remoulded moist soil with a clean knife blade or fingernail. A small sample of the soil at above plastic limit is kneaded into a ball about 25 mm in diameter and rubbed with a clean knife blade or fingernail. If the knife blade or fingernail leaves a shiny surface, the soil is highly plastic.
(c)	Dry strength or crushing resistance	Dry the prepared soil pat completely. Then measure its resistance to crushing and powdering between fingers. This resistance, called dry strength, is a measure of the plasticity of soil and is influenced largely by the colloidal fraction content. The dry strength is designated, As low, if the dry pat can be easily powdered. As medium, if considerable finger pressure is required and As high, if it cannot be powdered at all. Observe and record the dry strength as descriptive information.

Sr. No.	Field Test or Visual Examination	Procedure
(d)	Toughness or Consistency near plastic limit	Dry the pat used in the dilatancy test by working and moulding until it has the consistency of putty. The time required to dry the pat is the indication of plasticity. Roll the pat on a smooth surface or between the palms into a thread of about 3 mm in diameter. Fold and reroll the thread repeatedly to 3 mm in diameter so that its moisture content is gradually reduced until the 3 mm thread just crumbles. The moisture content at this time is called the plastic limit and the resistance to moulding at the plastic limits is called the toughness. After the thread crumbles, lump the pieces together and continue slight kneading action until the lump crumbles. If the lump can still be moulded slightly drier than the plastic limit and if high pressure is required to roll the thread between the palms of the hand, the soil is described as having high toughness. Medium toughness is indicated by a weak thread, it breaks easily and can not be lumped together when drier than the plastic limit. Highly organic clays have very weak and spongy feel at the plastic limit. Non-plastic soils can not be rolled into threads of 3 mm in diameter at any moisture content. Observe and record the toughness as descriptive information.

TABLE 3

LABORATORY TESTING OF SOILS

Sr No	TEST	FREQUENCY	EQUIPMENTS	ACCEPTANCE CRITERIA	PURPOSE OF TESTING
1	Grain size analysis IS : 2720- 4-1985 (Reaffirmed 2006) (Note 1 , at the end of Table 3)	As per relevant specification provisions or 1 per 1000 m^3	# Coarse sieve (80 mm, 63, 37.5, 25.0, 20.0, 10.0, 6.3 , 4.75 mm) # Fine sieves (2mm, 600 micron, 425, 212, 75 micron), # Balance(as per test type) # Oven, 110-115^{0}C # Stirrer, # Hydrometer (With Jars)	As specified	For classification of soil and there by getting indication of properties
2	Plasticity index IS : 2720-V-1985 (Reaffirmed 2006) (Note 2, at the end of Table 3)	As per relevant specification provisions or 1 per 1000 m^3	# Standard Cone Penetrometer, # Oven, # Ground Glass, # Spatula, # Balance,(as per test) # Containers.	As specified Workable range for Hearting (As per IS 1498) LL: 30 to 50 — PL: 15 to 20 — PI: 15 to 30	Indicates properties of soils. Test not possible for non plastic soils which are used for casing
3	Standard compaction IS : 2720-VII-1980 (Reaffirmed 1997)	As per relevant specification provisions or 1 per 1000 m^3	# Standard compaction mould 1000 cm^3 with base, collar and # Rammer of 2.6 kg, # Soil Extractor, # Balance 10 Kg (1 gm sensitive) # Oven, # Spatula	As per design	For determining the maximum density which can be attained on field at optimum moisture content, with standard energy input
3 A	Heavy compaction IS : 2720 (Part-VIII)-1983 (Reaffirmed 2001.)	As per relevant specification provisions or 1 per 1000 m^3	Same as above except # Compaction mould is 1000 cm^3 and 2250 cm^3 # Rammer of 4.9 kg	As specified	Same as above but with heavy energy

Sr No	TEST	FREQUENCY	EQUIPMENTS	ACCEPTANCE CRITERIA	PURPOSE OF TESTING
4	Relative density (Cohesionless soil) (Vibratory Tab) IS : 2720-XIV-1983 (Reaffirmed 2001)	As per relevant specification provisions or 1 per 1000 m^3	# Relative density apparatus, # Vibratory Table, # Balance 100 kg, sensitive 20 gm # Dial gauge 50 mm travel # Surcharge plates, # Moulds with base plate # Calib. bar	As specified	Similar as above but for coarse grained soils
5	Permeability IS : 2720-XVII-1986 (Reaffirmed 1997)	As per relevant specification provisions or 1 per 1000 m^3 or as required	# Permeability apparatus, # Soil Extractor,	As per I S:1498 – 1970 (Reaffirmed - 1970)	To decide drainage conditions under which the soil will behave in field, to anticipate probable seepage and design drains
6	Direct shear (for soil up to 4.75 mm size) IS : 2720-XIII-1986 (Reaffirmed 1997)	As per relevant specification provisions or 1 per 1000 m^3 or as required	# Direct shear apparatus, # Soil extractor, # Balance 1 kg. (sensitivity 0.1g) # Shear moulds with grid plates, # Porous stone, # Loading pad, # Dial gauge, # Proving ring # Stop cock	As per design	To determine shear strength of soil in foundation or in an embankment To find out safe bearing capacity of soil
6 A	For soil containing gravel more than 4.75 mm size IS :2720-XXXIX-1979 Section 1 (Reaffirmed 1997)	As per relevant specification provision or 1 per 1000 m^3 or as required	# Direct shear apparatus large size with all accessories, # Loading frame #Dial gauge #Spring balance 10 kg, Sens. 1kg #Datum bar #Rollers	As per design	To determine shear strength of soil in foundation or in an embankment
7	Triaxial compression (uu) IS : 2720 (Part XI)-1993 (Reaffirmed 1997)	As per relevant provision	# Triaxial shear apparatus, # Loading frame, # Pore pressure apparatus, # Constant pressure system, # Soil extractor, # Balance with (Accu. 0.5g) # Membrane stretcher,	As specified	To determine shear strength of soils in unconsolidated un drained condition (uu)

Sr No	TEST	FREQUENCY	EQUIPMENTS	ACCEPTANCE CRITERIA	PURPOSE OF TESTING
			# Split mould, #Proving ring, # Dial gauge etc.		
7 A	Triaxial compression (cu) IS : 2720 (Part - XII)- 1981 (Reaffirmed 1997)	As per relevant provision or 1 per 1000 m^3	# Triaxial shear apparatus, # Loading frame, # Pore pressure apparatus, # Constant pressure system, # Soil extractor, # Membrane stretcher, # Split mould, # Proving ring, # Dial gauge etc. #Rubber rings #Porous stone	As specified	To determine shear strength of soils in foundation or in embankment in consolidated un drained condition (cu) To find out S. B. C. of soil
8	Consolidation Properties IS : 2720-XV-1986 (Reaffirmed 1997)	1 set of 3 samples per season per zone at end of season or as specified	# Consolidation test apparatus. # Stop watch, (1 sec) # Oven 110-115^{0}C and extractor. # Balance (Sensitive 0.01g) #Porous stone #Loading device #Dial gauge #Jack and frame	As per design	To determine settlement rate and magnitude & to assess whether soil is normally consolidated or pre consolidated To determine allowable bearing pressure
9	Unconfined compression IS : 2720-X-1991 (Reaffirmed 2006)	As per relevant specification provisions or 1 per 1000m^3	# Compression device # Sample extractor or ejector # Dial gauge, (0.01 grads) # Oven, 110-115^{0}C # Balance (sensitive 0.01 to 0.1 gm as per wt. of sample)	As specified	To determine unconfined compressive strength of soil
10	Free swell index IS : 2720-(Part XL-1977 (Reaffirmed 1997)	As per relevant specification provision	# Sieve # Graduated glass cylinder 100cc capacity	As per sample	To determine swelling properties of soil

Sr No	TEST	FREQUENCY	EQUIPMENTS	ACCEPTANCE CRITERIA	PURPOSE OF TESTING
11	Swelling pressure of soils IS : 2720-(Part XLI-1977 (Reaffirmed 1997)	As per relevant specification provision	# Swell pressure apparatus or # Consolidometer # Dial gauge, # Proving ring # Water reservoir #oven #Desiccator #Balance , sensitive 0.01 gm	Refer IS 9451-1994 Table :1 A and I B for thickness of CNS layer at value of swell pressure	To determine swelling properties of soil
12	Pin hole test ASTM : D-4647-1993	As per relevant specification provision	# Pin hole test apparatus, # Graduated cylinder, # Compaction equipment, # Balance # Centering guide etc.	As specified	To know the dispersive characteristics of soil
FIELD TEST					
1	Dry density of soil in place (core cutter) 2720-XXIX-1975 (2006 RA)	1 per 300 m^3, minimum one in each zone per layer or as specified, 1 per 5000 m^3 for Rock fill	# Core cutter, Sand # Replacement kit # Water replacement kit # Balance accuracy 1gm # Steel rammer # Straight Edge	95 percent of MDD or 70 percent of RD Moisture OMC ±2 percent or as specified Above 70 percent RD or as specified	To determine the placement density and to monitor compaction effort. It also indicates adequacy of moisture content
2	Moisture content IS :2720 (Part-2)-1973 (Reaffirmed 2001)	1 per 300 m^3 or as specified	# Balance (Accuracy 0.04 % of soil mass) # Oven 110-115^{0}C or # Rapid moisture meter #Container #Desiccator	Depending upon OMC results	To determine degree of saturation, consistency rate of natural strata or a compacted soil
3	Field permeability (in situ) IS : 5529-I-1985 (Reaffirmed 1995)	1/3 m depth or as required	# Auger # Driving pipe # Storage drum # Delivery hose pipe # Plumb	Workable range for hearting, less than 10^{-6} cm/sec. Casing more than 10^{-4} cm/sec or as specified	To determine the drainage condition of soil in situ.

Sr No	TEST	FREQUENCY	EQUIPMENTS	ACCEPTANCE CRITERIA	PURPOSE OF TESTING
4	Standard Penetration Test (SPT) IS : 2131-1981 (Reaffirmed 1997)	1.5m to 2.0m depth in bore hole or as specified	# Drilling equipment, # Split spoon sampler, # Drive weight assembly, # Screw jack	As specified	To determine penetration resistance of sub soil in terms of standard penetration number (N).
5	Dynamic Cone Penetration Test (DCPT) IS : 4968-Part-I-1976 (Reaffirmed 1997) IS : 4968-Part-II-1976 (Reaffirmed 1997)	Continuous in bore hole up to specified depth	# Standard cone, # Driving head, # Hoisting equipment # Hammer etc. (65 kg with chain)	As specified	To determine penetration resistance of sub soil (Strata wise)
6	Load Test on soil IS : 1888-1982 (Reaffirmed 1997)	As specified	# Plates of different sizes, # Loading device, # Dial gauge, # Hydraulic jack, # Datum bar etc.	As specified	To determine load deformation characteristic of sub soil and to determine SBC and ABP values
7	Pressure meter Test I S : 1892-1979 (Reaffirmed 1997)	As specified	# Pressure Meter Assembly	As specified	To determine SBC and deformation characteristic of soil
8	For soil containing gravel and cobblestone IS :2720-XXXIX-1979 Section 2 (Reaffirmed 1997)	As specified	# Direct shear apparatus as per IS # Loading Plate #Hydraulic Jack # balance 10 kg, Sens. 1kg #Datum bar #Rollers	As per design	To determine (in situ) shear strength of soil containing gravel and cobblestone.

Note 1: IS 2720 (Part 4): 1985 specifies grain size analyses, depending upon the grain size and soil retained on IS sieves , the methods are elaborated.

Note 2: IS 2720 (Part 5) : 1985 lays down methods of test for the determination of the liquid limit and plastic limit of soil. Three methods namely mechanical method, one point method and cone method are given for the determination of liquid limit.

Table 4

LIST OF INDIAN STANDARD-SOILS

UPDATED FROM CATALOGUE OF BUREAU OF INDIAN STANDARD 1997

Sr. No.	IS: Code No.	Title
1	1498-1970 Reaffirmed- 2007	Classification and Identification of soils for general engineering purposes
2	1888-1982 Reaffirmed 2007	Method of load test on soils
3	1892-1979 Reaffirmed 2007	Code of practice for sub surface investigations for foundations
4	1904-1986 Reaffirmed 2005	Code of practice for design and construction of foundation in soils, General requirements
5	2131-1981 Reaffirmed 2007	Method of standard penetration test for soils
6	2132-1986 Reaffirmed 2007	Code of practice for thin walled tube sampling of soils
7	2720 (Part 1) – 1983 Reaffirmed 2005	Methods of test for soils: Part 1. Preparation of dry soil samples for various tests.
8	2720 (Part 2) – 1973 Reaffirmed 2005	Methods of test for soils: Part 2. Determination of water content.
9	2720 (Part 3/Sec.1) – 1980 Reaffirmed 2007	Methods of test for soils: Part 3. Determination of specific gravity, Sec. I, Fine grained soils
10	2720 (Part 3/Sec.2) – 1980 Reaffirmed 2007	Methods of test for soils: Part 3. Determination of specific gravity Sec.2, Fine medium and coarse grained soils
11	2720(Part 4)–1985 Reaffirmed 2005	Methods of test for soils: Part 4. Grain size analysis
12	2720(Part 5)–1985 Reaffirmed 2005	Methods of test for soils: Part 5. Determination of liquid and plastic limit
13	2720(Part 6)–1972 Reaffirmed 2007	Methods of test for soils: Part 6. Determination of shrinkage factors
14	2720(Part 7)–1980 Reaffirmed 2007	Methods of test for soils: Part 7. Determination of water content-dry density relation using light compaction
15	2720 (Part 8)– 1983 Reaffirmed 2005	Methods of test for soils: Part 8. Determination of water content-dry density relation using heavy compaction
16	2720(Part 9)–1992 Reaffirmed 2007	Methods of test for soils: Part 9. Determination of dry density – moisture content relation by constant weight of soil method.
17	2720 (Part 10) – 1991 Reaffirmed 2005	Methods of test for soils: Part 10. Determination of unconfined compressive strength.
18	2720 (Part 11)– 1993 Reaffirmed 2007	Methods of test for soils: Part 11. Determination of the shear strength parameters of a specimen tested in unconsolidated undrained triaxial compression without the measurement of pore water pressure.

Sr. No.	IS: Code No.	Title
19	2720 (Part 12)–1981 Reaffirmed 2007	Methods of test for soils: Part 12. Determination of shear strength parameters of soil from consolidated undrained triaxial compression test with measurement of pore water pressure.
20	2720 (Part13)–1986 Reaffirmed 2007	Methods of test for soils: Part 13. Direct shear test
21	2720 (Part 14)–1983 Reaffirmed 2005	Methods of test for soils: Part 14. Determination of density index (relative density) of cohesion less soils
22	2720 (Part 15)–1986 Reaffirmed 2007	Methods of test for soils: Part 15. Determination of consolidation properties.
23	2720 (Part 16)–1987 Reaffirmed 2007	Methods of test for soils: Part 16. Laboratory determination of CBR.
24	2720 (Part 17)–1986 Reaffirmed 2007	Methods of test for soils: Part 17. Laboratory determination of permeability
25	2720 (Part 18)–1992 Reaffirmed 2007	Methods of test for soils: Part 18. Determination of field moisture equivalent .
26	2720 (Part 19)–1992 Reaffirmed 2007	Methods of test for soils: Part 19. Determination of centrifuge moisture equivalent
27	2720 (Part 21)–1977 Reaffirmed 2005	Methods of test for soils: Part 21. Determination of total soluble solids .
28	2720 (Part 22)–1972 Reaffirmed 2005	Methods of test for soils: Part 22. Determination of organic matter .
29	2720 (Part 23)–1976 Reaffirmed 2005	Methods of test for soils: Part 23. Determination of calcium carbonate.
30	2720 (Part 27)–1977 Reaffirmed 2005	Methods of test for soils: Part 27. Determination of total soluble sulphates
30 A	2720 (Part 29) - 1975 Reaffirmed 2005	Methods of test for soils: Part-29: determination of dry density of soils in-place by the core-cutter method.
31	2720 (Part 31)–1990 Reaffirmed 2005	Methods of test for soils: Part 31. Field determination of California Bearing Ratio
32	2720 (Part 36)–1987 Reaffirmed 2007	Methods of test for soils: Part 36. Laboratory determination of permeability of granular soils (Constant head)
33	2720 (Part 39/Sec.1) – 1977 Reaffirmed 2007	Methods of test for soils: Part 39. Direct shear test for soils containing gravel, Sec.1, Laboratory test

Sr. No.	IS: Code No.	Title
34	2720 (Part 39/Sec.2) – 1979 Reaffirmed 2007	Methods of test for soils: Part 39. Direct shear test for soils containing gravel. Sec.2 In-situ shear test
35	2720 (Part 40)– 1977 Reaffirmed 2007	Methods of test for soils: Part 40. Determination of free swell index of soils.
36	2720 (Part 41)– 1977 Reaffirmed 2007	Methods of test for soils: Part 41. Determination of swelling pressure of soils,
37	2809-1972 Reaffirmed 2005	Glossary of terms and symbols relating to soil engineering .
38	2911 (Part 4) – 1985 Reaffirmed 2002	Code of practice for design and construction of pile foundations. Part 4, Load test on piles
38 A	4332 (Part I) - 1967 Reaffirmed 2005	Methods of test for stabilized soils Part-1 -Method of sampling & preparation of stabilized soils for testing
39	4434-1978 Reaffirmed 2007	Code of practice for In-situ vane shear test for soils
40	4701-1982 Reaffirmed 2009	Code of practice for earthwork on canals.
41	4968 (Part 1) - 1976 Reaffirmed 2007	Method for subsurface sounding for soils (Part 1) Dynamic method using 50 mm cone without bentonite slurry
42	4968 (Part 2) – 1976 Reaffirmed 2007	Method for subsurface sounding for soils (Part 2) Dynamic method using cone and bentonite slurry
43	4968 (Part 3) – 1976 Reaffirmed 2007	Method for subsurface sounding for soils (Part 3) Static cone penetration test
44	5529 (Part 1) – 1985 Reaffirmed 2009	Code of practice for In-situ permeability test (Part 1) Test in overburden
45	6403-1981 Reaffirmed 2007	Code of practice for determination of bearing capacity of shallow foundations
46	6955-2008 Not reaffirmed	Code of practice for subsurface exploration for earth and rock fill dams,
47	8009 (Part 1) – 1976 Reaffirmed 2008	Code of practice for calculation of settlement of foundations (Part 1) Shallow foundations subjected to symmetrical static vertical loads
48	8009 (Part 2) – 1980 Reaffirmed 2005	Code of practice for calculation of settlement of foundations (Part 2) Deep foundations subjected to symmetrical static vertical loading
48 A	8237 - 1985 Reaffirmed 2007	Code of practice for protection of slope for reservoir embankment
49	8763-1978 Reaffirmed 2007	Guide for undisturbed sampling of sand and sandy soils,
50	9214-1979 Reaffirmed 2007	Method for determination of modulus of sub grade reaction (K-value) of soils in the field

Sr. No.	IS: Code No.	Title
51	9451-1994 Reaffirmed 2009	Guidelines for lining of canals in exp. soils
52	9640-1980 Reaffirmed 2007	Split spoon sampler
53	10042-1981 Reaffirmed 2007	Code of practice for site investigations for foundation in gravel boulder deposits,

TABLE 5

QUANTITY OF SOIL SAMPLE REQUIRED FOR DIFFERENT TESTS

Sr. No.	Test	Quantity required for soils having maximum particle size of				
		4.75 mm	10 mm	20 mm	40 mm	80 mm
1	Grain size analysis	400 gm	1.5 kg	6.5 kg	25 kg	60 kg
2	Liquid limit	270 gm	-	-	-	-
3	Plastic limit	50 gm (Passing 425 micron)	-	-	-	-
4	Shear	3 kg	120 kg	120 kg	120 kg	120 kg
5	Consolidation	Undisturbed sample 75 mm dia	-	-	-	-
6	Permeability	5 kg	15 kg	30 kg	120 kg	120 kg
7	Proctor (a) Light compaction (b) Heavy compaction	 20 kg 20 kg	 20 kg 20 kg	 20 kg 20 kg	 - -	 - -
8	Relative density	12 kg	25 kg	50 kg	100 kg	120 kg
Total for all tests		**65 kg**	**200 kg**	**250 kg**	**365 kg**	**420 kg**

TABLE 6

EARTH WORK

DO'S	DON'TS
• Conduct density test at random intervals for specified quantum of earthwork	• Have square grid locations for density determinations
• Correction for oversize material should be effected in evaluation of placement density	• Careless rolling operation near a structure
	• Improper choice of roller for different types of soils
• Always drive core-cutter to its full length	• Over drive the core cutter
• Use standard equipment for density test based on thickness of layer and compacting material used.	• Deploy non standard equipment
• Determine moisture content immediately after weighing the wet soil	• Delay moisture determination
• Insist on specified thickness of layer	• Allow thicker layers
• Provide extra width for slope dressing	• Work with tight widths and lengths
• Allow next layer only after attaining specified density	• Allowing of next layer without attaining specified density

TABLE 7

O. K. CARD FOR EARTH WORK

Name of work : Name of Division:

Reach & Location : Name of Sub-Division :

A	**BANK SEAT PREPARATION**		
	(1)	Whether the overburden, roots and foreign material are removed from the bank seat?	Yes/No
	(2)	Whether the width of bank seat demarcated at site?	Yes/No
	(3)	Whether bank seat has been moistened sufficiently and compaction done?	Yes/No
	(4)	Whether the levels are recorded?	Yes/No
	(5)	Whether density and FMC are taken for approval of seat?	Yes/No
	(6)	Findings of test results	
		% compaction_____ % FMC_____	
B	**BORROW AREA**		
	(1)	Name and Location_____	
	(2)	Whether the required overburden roots and foreign materials are removed?	Yes/No
	(3)	Whether the grid lines marked (3 m x 3 m or as specified) and levels taken?	Yes/No
	(4)	Whether samples were collected for testing and test results are available?	Yes/No
	(5)	Type of material_____	
		Quantity of material expected to be available	
C	**EMBANKMENT**		
	(1)	Whether the seat for the embankment is approved?	Yes/No
	(2)	Whether filter is required?	Yes/No
	(3)	Are filter criteria fulfilled? Specify the details_____	
	(4)	Whether proper compaction of filter is achieved? _____ % compaction	

	(5)	Layer number/R.L _____ m	
	(6)	Whether the embankment in different zones and different layers is raised in specified thickness?	Yes/No
	(7)	Whether the required watering and compaction done?	Yes/No
	(8)	Are density and moisture content test taken	Yes/No
		% compaction _____ % FMC _____	
	(9)	Whether trip cards for dumpers, water tankers are maintained and available on site?	Yes/No
	(10)	Remarks	
Signature of Deputy Ex. Engineer			**Signature**

Table 8

RECORDS TO BE MAINTAINED

(1) Data of earth work as indicated in design note and drawing of embankment section.

(2) Record of properties of soils available from excavations and borrow areas.

(3) Confirmatory tests of soil being used for embankment (during construction).

(4) Compaction test results of earth layer and base seat of embankment.

(5) Data for proctor test for each type of material used.

(6) Moisture control (before spreading NMC & comparison/difference of OMC).

(7) Determination of FDD/FMC and comparison with design data.

(8) Layer wise R. L. location etc.

(9) Daily and Monthly progress report.

(10) Record for filter material used shall be maintained such as filter criteria, gradation, curve, compaction/watering etc.

(11) Records of machinery deployed/trips/output etc.

TABLE 9

DAILY REPORT ON TESTS TO BE CARRIED OUT FOR EARTH WORK

Date: **Month :** **Year :**

Name of work		**:**	
Chainage/Location		**:**	
Agreement No.		**:**	
Name of Agency		**:**	
Name of Division		**:**	
Sub-Dn.		**:**	
Circle		**:**	

Sr No	**Item**	**No. of test required as per norms or as per tender provisions**	**Quantity of earth work m^3**	**No. of tests carried out per Norms**	**Nos. of tests satisfying the acceptable criteria as per tender**	**Nos. of tests repeated and Nos. of test satisfactory after re-rolling and watering**	**Remark**
1	Embankment (a) FDD/FMC (b) Compaction (Proctor)						
2	Backfilling (a) FDD/FMC (b) Proctor test						
3	Lining (a) Sub grade (b) Compaction FDD/FMC						

Signature of field officer

Signature of Deputy Ex. Engineer

ABBREVIATION

ABBREVIATIONS	:	FULL FORM
Atterbergs Limits	:	Plasticity Index Test
FDD	:	Field Dry Density
FMC	:	Field Moisture Content
LL	:	Liquid Limit
M.A	:	Mechanical Analysis (Hydrometer Test)
MDD	:	Maximum Dry Density
OMC	:	Optimum Moisture Content
NMC	:	Natural Moisture Content
PL	:	Plastic Limit
PI		Plasticity Index
Proctor	:	Compaction Test
RD	;	Relative Density
SBC	:	Soil Bearing Capacity
S.A	:	Sieve analysis
SPT	:	Soil Penetration Test
Tri axial Compression (uu)	:	Unconsolidated Undrained condition
Tri axial Compression (cu)		Consolidated Undrained condition

Part II
CONSTRUCTION MATERIALS

GUIDELINES FOR CONCRETE

1.0 INTRODUCTION:

Concrete, which externally appears to be crack-free, is sometimes found to be defective especially with layer lines and other discontinuities inside, against requirement of monolithic nature of concrete when tested with non destructive methods. Hollows below reinforcement, inadequate cover, displacement of reinforcing bars and heavy corrosion to reinforcement are noticed after removal of cover in concrete of slab and beam. Surfacial defects like honeycombing shrinkage cracking, pour lines, entrapped air voids, unevenness of surface are very common. The cold joints occur in concrete because pouring rate is inadequate. The cold joints when left untreated develop into plane of separation. This is the result of non-observance of standard/good practices to produce good concrete on field at the time of concreting. It is therefore necessary that good practices for manufacture of good concrete and necessary precautions are taken during concreting. Guidelines during inspection for preparatory work i.e. batching, mixing, conveying, placing, consolidating, finishing & curing are as follows.

2.0 INSPECTION FOR PREPARATORY WORK:

Before concreting work begins, preliminary field inspection is essential to ensure better results.

2.1 Mixer: Check

- Revolution of drum per minute.
- Cleanliness inside drum.
- Number of mixing blades inside drum and the gap between drum & blades shall not be larger than 25mm.
- Water tightness of drum.
- Leveling of mixer on leveled ground.
- Working of discharge of chute and hopper.
- Working of water tank fitted with mixer, gauge mark.
- Capacity of drum.

2.2 Weight/Volume Batching Arrangement: Check

- Sensitivity of Balances.
- Measurements of boxes.
- Adjustable arrangements in boxes.
- Weight of boxes.

2.3 Materials:

2.3.1 **Cement:** The requirements of various tests of cement are given in Table No. 3 & 4 and the other requirements are as under:

- Type of cement and source.
- Freshness of cement (should not be older than three months).
- Weight of cement bags.
- Storing condition, dry floor.
- Cement account and adequate stock to complete concrete work.

2.3.2 **Sand:** The requirements of various tests on sand are given in Table No 11 and the other requirements are as under :

- Source and type.
- Moisture content.
- Gradation, fineness, silt content.
- Adequate stock.

2.3.3 **Gravel/Metal:** The requirements of various tests of gravel/metal are given in Table No.10 and the other requirements are as under :

- Type and source.
- Gradation.
- Adequate stock.

2.3.4 **Water:** The requirements of various tests of water are given in Table No. 21 and the other requirements of it as under :

- Potable water.
- Silt free.
- Measuring arrangement.

2.3.5 **Admixture:** The requirements and the other details of various tests on Admixture are given in Table No. 24.

- Type and Source
- Dosage
- Measuring arrangement

2.4 Foundation:

2.4.1 Rock Surface

- Check-lines & levels, obtain clearance of Geologist.
- Inspect with Hammer for hollow sound.
- Remove loose rock.
- Clean with air and water jets under pressure.
- Keep surface wet for 24 hrs before placement of concrete.
- Ensure adequate drainage or dewatering or caulking for leaks.

2.4.2 Soil Surface:

- Remove loose or soft patches.
- Moisten the surface to a depth of about 15 cm.
- Do tamping or rolling.
- Cover the surface with tar paper or closely woven burlap with proper lap and fastening.

2.4.3 Concrete surface

- Remove loose material.
- Existing concrete should be wet sand blasted & washed thoroughly.
- Completely dried immediately prior to placement.

2.5 Computations

- Work out batch weights of cement/sand and gravel/metal to suit the capacity of mixer, in proportion to design mix.
- Apply moisture / bulkage corrections to sand and gravel/metal.
- Check water meter / gauge.

2.6 Quality control tests: The requirements and the other details of various tests on cement concrete are given in Table No. 17.

- Mixer efficiency test, decide mixing time and batch weight of cement.
- Slump test.
- Yield test.
- Air content test.
- Set of specimens for compressive strength and permeability.
- Records – Batch weight register, cement consumption register, F.M. register, gravel/metal register, weight/volume register, slump test register, air content register, yield test register, compression and permeability test register, work order book and progress book.

2.7 Form work:

- Firmness of ground supporting props when it becomes wet.
- Straightness of props.
- Adequate bracing.
- Nailing loose or tight, adequate penetration of nail in lower member.
- Leak proof.
- Strong enough to resist movement of labourers and vibrations.
- Cleanliness of form work.
- Evenness of planks or plates, within tolerance limits as per IS 456:2000 (Reaffirmed 2005) as given below:
  a) Deviation from dimensions of cross-section of columns and beams -6mm, + 12mm.
  b) Deviation from dimensions of footings:
     i) Dimension in plan – 12 mm.
     ii) Eccentricity – 0.02 times the width of footing in direction of deviation but not more than 50 mm .
     iii) Thickness $\pm$ 0.05 times the specified thickness.
  c) Check calculation for formwork of heavy structure.

2.8 **Reinforcement:** The requirements and the other details of various tests on steel are given in Table No. 7 & 8.

- Check size, spacing, location, numbers etc. as per schedule of reinforcement/design drawing.
- Ensure staggering of overlaps.
- Embedded fixtures and openings.
- Reinforcement free from grease, oil and rust.
- Check up welding joints, bent up bars, hooks and cold bending.
- Rack arrangement for movement of laborers to prevent disposition of reinforcement.

3.0 BATCHING:

The aim of batching and mixing is to produce uniform concrete at required proportion. To attain this it is necessary that –

3.1 Materials are maintained homogeneous and non-segregated prior to and during batching.

3.2 The equipment provided for batching will accurately batch the required amount of material.

3.3 The required proportions of materials are maintained from batch to batch.

3.4 All materials are introduced into the mixes in proper sequence.

3.5 Weigh Batching:

a) Quantity of cement and aggregates should be determined by mass. Where bag is considered as batch weight, reasonable number of bags should be weighed periodically to check net mass.
b) Water should be measured by volume in calibrated tank or weighed.

3.6 Blending of aggregates may be carried out as and when required.

3.7 Gradation of coarse and fine aggregates should be done frequently.

3.8 In case uniformity in the materials used for concrete making has been established over a period of time, the proportioning may be done by volume batching, provided periodic checks are made on mass/volume relationships of the materials.

3.9 Moisture/bulkage corrections should be applied for moist materials.

4.0 MIXING:

4.1 The mixing shall be continued until there is a uniform distribution of the materials and the mass is uniform in colour and consistency.

4.2 If there is segregation after unloading from the mixer, the concrete should be remixed.

4.3 For guidance, the mixing time may be one and a half to two minutes.

4.4 In exceptional circumstances such as mechanical break down of mixer, work in remote areas or when the quantity is small, hand mixing may be permitted subject to adding 10 percent extra cement. When hand mixing is permitted, it shall be carried out on a watertight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency.

4.5 Workability shall be checked at frequent intervals.

4.6 The freshly mixed concrete should be finally placed in position within 30 minutes.

4.7 Freshly mixed concrete, should be tested for slump, mixer uniformity tests, yield test, unit weight, air content and compressive strength etc.

5.0 CONVEYANCE / TRANSPORTATION:

5.1 Concrete shall be conveyed from mixer to final place of deposition as rapidly as practicable by methods which will prevent segregation or loss of slump and loss of materials including water.

5.2 Conveying method and equipment shall be approved by the engineer-in-charge not below the rank of Deputy Executive Engineer.

5.3 Newly mixed concrete is susceptible to segregation if dropped through height. The unrestrained dropping of concrete on apex of a pile also results in coarser particles segregating and concentrating at the toe of the slope. Unrestrained dropping, chuting and horizontal flow of concrete should not be permitted.

5.4 Minimum handling and persistent precautions should be observed to prevent segregation and to see that concrete remains a cohesive mass.

5.5 During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to reduce the loss of water by heat loss in cold weather may also be adopted.

6.0 PLACEMENT:

6.1 When slabs and beams & the supporting walls & columns are cast monolithically the concrete in the top 60 or 90 cm of walls & columns should be of the lowest slump that can be vibrated adequately & should be fully consolidated at the surface,

- After placing the fillet, beam and slab concrete, the vibrator should penetrate & re-vibrate the concrete in the tops of walls and columns.
- Concrete should be continued without avoidable interruptions until the placement is completed or until satisfactory construction joints can be made.

6.2 Concrete should be deposited in horizontal layers. Each layer should be compacted thoroughly before succeeding layer is placed. In reinforced concrete work, it is good practice to place concrete in layers 0.25m thick. However, thickness shall be decided in view of size and shape of section, consistency of concrete, spacing of reinforcement, method of concrete placement, method of compaction and necessity of depositing concrete of next layer before hardening of previous layer which takes place within 30 minutes.

6.3 Concrete shall be deposited continuously in order to avoid appearance of slightest layer line on the finished structure. No construction joint should be allowed to form unless directed by the designer.

6.4 Placement of concrete shall be carried out at such a rate that lower layer concrete which is being integrated with fresh concrete is always plastic. Normally this will be achieved if next layer is placed within 30 minutes. If this is not done, cold joints will develop which must be avoided. The cold joints are interfaced which remain as discontinuities and cause separation when subjected to tensile stresses.

6.5 Placing of concrete in supported elements shall not be started until the concrete previously placed in columns or wall is no longer plastic and has been in place , at least for two hours.

6.6 The concrete should be worked thoroughly into all positions around reinforcement, embedded fixutres and into corners of form work. Only slurry, if allowed to pass below reinforcement gives a firm finish but leaves voids near reinforcement and hence causes loss of bond and corrosion.

7.0 CONSOLIDATION:

7.1 Concrete shall be consolidated by vibration, spading, roding or forking so that concrete is thoroughly worked around the reinforcement, around embeded items and into concrete of forms, eliminating all air or stone pockets which cause honeycombing, pitting or planes of weakness.

7.2 Internal vibrators shall have a minimum frequency of 8000 vibrations per minute with sufficient amplitude to consolidate concrete effectively.

7.3 Vibrators shall be inserted vertically and withdrawn gradually at points approximately 0.4 to 0.5m apart. At each insertion, the duration shall be 5 to 15 seconds which is sufficient to consolidate the concrete but to disallow segregation and increase in surface laitance.

7.4 Where the concrete is to have coat finish, a full layer of mortar shall be brought against the form by vibration process.

7.5 Vibrators shall be operated by competent workman.

7.6 A spare vibrator shall be kept on site of work during all concrete placing operations.

7.7 Whenever vibration has to be applied externally the design of form work and the disposition due to vibrators should receive special consideration to avoid surface blemishes.

7.8 The use of suitable mechanical vibrators complying with IS: 2505-1992 (Reaffirmed 2008), IS:2506-1985 (Reaffirmed2005), IS:4656-1968 (Reaffirmed 2007) is recommended.

7.9 Over vibration or vibration of very wet mixes is harmful and should be avoided. Under vibration is also harmful. Complete consolidation can be judged by evidence of leveled appearance of concrete at exposed surface, embedment of surface aggregate, expulsion of entrapped air, formation of cement skin and appearance of cement slurry at surface.

8.0 FINISHING:

8.1 The quality of concrete surface is judged by condition and appearance of the finished surface. The exposed surfaces are subjected to more or less severe conditions of wetting or drying, temperature changes, mechanical wear etc.

8.2 Concrete proportions and consistency and methods of compaction should be such that sufficient mortar is available at the surface for finishing purposes.

8.3 Floats shall be used to remove high and low spots and to produce a true plane surface. High and low areas should be corrected at once.

8.4 Over sanded or too wet or over consolidated mix is likely to be covered with bleeding water. They may be corrected for better finishing. Such water shall be allowed to drain or absorb or scrap.

8.5 Any water which comes to surface during drying or floating operations should be allowed to evaporate before surface is floated with hand floats or trowelling. If the amount of water of laitance is excessive it should be scooped off before surface is again floated.

8.6 Sprinkling of dry cement or a dry mortar should not be permitted.

8.7 All finishing operations should be controlled so as to prevent bringing an excess of paste to the surface.

8.8 Trowelling should be delayed as long as possible. Final floating is used to remove remaining minor irregularities. The concrete is ready for floating when any sheeny water has disappeared and when a man standing on surface will leave an imprint of about 5mm.

8.9 The proper time of trowelling varies with cement, weather and other conditions. It is ready when surface just reaches the stage that it can no longer be dented with finger.

8.10 If surface is trowelled too soon, a layer of laitance is found, if too late, the partly hardened concrete is too hard to be trowelled effectively.

8.11 During trowelling the steel trowel should be tilted at a slight angle and heavy pressure should be exerted to compact the paste and form a dense hard surface.

9.0 STRIPPING PERIOD:

9.1 Removal of form depends upon grade of concrete, type of member, weather conditions, winds, strength attained, type of cement etc. Early removal of form is desirable for finishing and is usually desirable from points of view of airing.

9.2 Forms shall not be struck until the concrete reaches strength at twice the stress to which the concrete may be subjected at the time of removal of formwork.

9.3 Wherever possible, the formwork shall be left longer as it would assist the airing.

9.4 In normal circumstances and where Ordinary Portland Cement is used, forms may generally be removed after expiry of the following periods as per IS: 456-2000 (Reaffirmed 2005)

a.	Walls, columns and vertical faces of all structural members	16 to 24 hours
b.	Slabs (props left under)	3 days
c.	Beam soffits (props left under)	7 days
	Removal of props under slabs: 1. Spanning upto 4.5 2. Spanning over 4.5 m	 7 days 14 days
	Removal of props under beams and arches: 1. Spanning upto 6 m 2. Spanning over 6 m	 14 days 21 days
d.	Modify stripping time suitably for other cements	

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

10.0 CURING:

Curing is defined as maintenance of humidity and temperature of freshly placed concrete during definite period following finishing assuring satisfactory hydration of cementious material and proper hardening of the concrete. The curing period depends upon type of cement, weather condition, wind speed, stripping time, sections of concrete, methods of curing, etc. Improper curing results in formation of surface / shrinkage cracks, loss of strength, increase in permeability, spoilage of surface finishing, decreases durability and quality of concrete is affected. Moist curing, membrane curing are normally used. Former is predominantly used.

10.1 Exposed surface of concrete shall be kept continuously in damp or wet condition by ponding or by covering with a layer of sacking, canvas, or similar materials and kept constantly wet for at least seven days.

10.2 The curing period should be increased by one week for pozzolonic cement for best results.

10.3 The freshly laid concrete shall be protected from direct exposure to sun and high winds.

10.4 The curing in hot weather conditions i.e. temperature above 40oc needs special attention to disallow rapid evaporation and prevent plastic shrinkage cracking.

10.5 Membrane curing: Approved curing compounds may be used in lieu of moist curing. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. The requirements and other details are given in Table No.22

11.0 CONCRETING UNDER SPECIAL CONDITIONS:

a) Underwater concreting: Do not place concrete in running water, use rich mixes, use tremie or direct pumping, ensure continuous placement.

b) Hot weather concreting: Dampen the sub grade and forms, place concrete at the lowest practicable temperature, start curing early, use cold water or ice as a part of mixing water.

c) Cold weather concreting: Prevent concrete from freezing, concrete should be placed at temperature not lower than 5^{o}C, maintain curing condition which fosters normal strength development without excessive heat, keep surface at a temperature that may not cause early freezing or seriously prolong hardening.

d) The general environment to which the concrete will be exposed during its working life is classified into five levels of severity that is, mild, moderate, severe, very severe & extreme as described in Table 3 of IS 456 : 2000 (Reaff.2005). For example for severe environment, exposure conditions are concrete surfaces exposed to severe rain, alternate wetting & drying or occasional freezing whilst wet or severe condensation, concrete completely immersed in sea water, concrete expose to coastal environment. For different exposure conditions refer Table 5 of IS 456 : 2000 (Reaff. 2005) for minimum cement content, maximum water cement ratio and minimum grade of concrete. For example, for RCC, minimum grade of concrete, minimum cement content & maximum free water cement ratio are M30, 320 kg/m3 and 0.45 respectively for “Severe Exposure”. Also refer Table 16 of IS 456 : 2000 (Reaff. 2005) for Nominal Cover to meet Durability Requirements.

12.0 RECORDS AND REPORTS:

Check registers of cement consumption, fineness modulus, aggregate quality and quantity, weight/volume batching, tests for fresh concrete and for specimens for compressive strength and permeability, examine critically work order book, review test results and review design mix, ensure monthly summary reports giving compliance of instructions recorded in work order book.

13.0 POINTS TO REMEMBER WHILE LAYING MASONRY

a) Brick work: The requirements and the other details of various tests on bricks are given in Table No. 12 & 13.

1) Ensure thorough soaking of bricks in clean water for 24 hrs. before use.
2) See the workmanship for bond, thickness of joint, finishing of joint etc.
3) Courses should be truly horizontal and joints truly vertical.
4) Restrict use of brickbats to a minimum.
5) English bond preferable.
6) Thickness of joint should be uniform and not more than 13 mm.
7) Specified cement mortar should be placed within 30 minutes after addition of water.
8) Bricks on edge should not be used unless specified.
9) Disallow vertical joint filling by spreading mortar.
10) Masonry may be raised up to 90 cm in a day. Raising with all connected brickwork be carried out at one level.
11) The buttress, counter forts should be built simultaneously, maintaining proper bond with main wall and not added afterwards.
12) Fixtures of frame should be embedded while raising masonry.
13) The joints should be raked to a depth of 13 to 19 mm when mortar is green. If plaster or pointing is not to be done, the joints should be struck flush.
14) Curing should be done for at least seven days or as laid down in specifications.
15) Old or dry surface should be thoroughly cleared and wetted, joints raked before starting.

b) Stone work: The requirements and the other details of various tests on stone are given in Table No. 9.

Additional points for stone work are as under,

1) Rubble should be as per specifications.
2) Stone should be laid on their natural bed.
3) Through stones should be used at regular intervals in staggered manner.
4) Quoins should be used for openings. The width should be at least 1.5 times the depth of course and its length should be twice its depth.
5) Wet the stones before use.

6) Spauls shall be used wherever necessary to avoid thick mortar beds for joints and shall not exceed 10 %.
7) The use of wooden mallet must be carried out to Hammer down stone in to position and solidly bedded in the mortar.
8) Iron templates shall be used to compact the mortar in joints.
9) Every stone shall be carefully fitted to the bed and adjacent stone so as to form neat and close joints. No joints shall be thicker than 35mm.
10) All exposed surfaces shall be kept moist at least for 21 days.
11) Permeability tests shall be carried out as provided in specifications.
12) For pitching work (stone), only tested and non reactive stones should be used. To avoid dislocation/disturbance in stone pitching, provide panels at suitable intervals or use Gabion depending on site condition.
13) IS codes for reference are as under :
- IS code 1597 Part 1 1992 : Construction for Stone Masonary – Code of Practice
-IS code 1597 Part 2 1992 : Construction of Ashlar Masonary – Code of Practice
- IS 8605 – 1977 (Reaffirmed 2003), Code of practice for construction of Masonary in Dams
14) The type of rocks shall be identified according to characteristics given in Table 1 of IS 1123 – 1975
15) For additional tests viz. Durability (soundness) test and Toughness test, refer IS 1126-1974 & IS 5218-1969 respectively.

c) Plaster work:

- The details are covered in IS: 1661 – 1972 (Reaffirmed 2006).
- Thickness of single coat shall be between 10 to 15mm.
- Thickness of two coat plaster shall not exceed 20mm (Backing coat 10 to 12mm, finishing coat 8 to 10 mm).
- Plastering work to be suspended during frosty weather. It shall also be suspended in extreme dry condition.
- The walls shall be damped evenly before application of plaster.
- Drying shrinkage of first coat or backing material should be complete before application of subsequent coat.

14.0 STORAGE OF CEMENT:

1. Check for age of cement – Retesting to be done if cement is older than three months.
2. To be stored on raised platform.
3. Shall be stocked properly away from walls, facilitate for physical verification.
4. Maintenance of cement register and it shall be checked by senior officers.
5. Leak-proof ceiling.

15.0 ANALYSIS OF CEMENT & CONCRETE

When large work of cement mortar or cement concrete is to be done, analysis of cement testing is important. For analysis, first arrive at the limit of variability i.e. standard deviation or co-efficient of variation. On the basis of the target average strength of cement samples and the statistical parameters of variability, the test

results should be compared with suitable control charts. These charts are very convenient device to keep track on the monitoring of activity. Very useful information on evaluation of strength test results of concrete is given in ACI 214R-02. Recommended Practice for evaluation of strength test results of concrete, Indian Standards IS : 397 : 2003 (Part 1 to 3) (Reaffirmed 2008) cover control charts for general and special application in industrial application. Different charts for cement and concrete are (I) Master Chart (2) Moving average strength chart (3) Within-test moving average range chart (4) between test moving average range charts. The control charts can also incorporate certain reference lines as limits. As a general concept, four limits can be defined viz. lower as well as upper warning and action limits.

16.0 CEMENT CONCRETE LINING

Points to be observed for proper exercise of the functions

- Sub grade approval i.e. degree of compaction & moisture content.
- Testing of construction materials i.e. fine aggregate, coarse aggregate, cement, water, Air entraining agent, & curing compound.
- Checking of paver's Jack level, girder's alignment, roller movement.
- Test for concrete.
- Placement of concrete & arrangement of conveyor belt etc.
- Proper insertion of crack inducing joints in transverse and longitudinal directions, if specified
- To ensure specified thickness of cement concrete lining.
- Testing of hardened concrete.
- Care to be taken to check positioning of water stop insertion in C.C. lining.
- To undertake screening of green concrete for examining consistency of concrete (occasionally).
- Proper curing arrangements.

17.0 QUALITY CONTROL OF BRICK / TILES LINING

- Sub grade approval i.e. degree of compaction & moisture content.
- Testing of construction materials i.e. Brick / Tiles, Sand, cement and water.
- To ensure the correct batch weight as per the mix design of mortar and to check the mortar consistency
- Proper arrangement for soaking of brick / tiles.
- Curing arrangement.
- Mixing of mortar – consistency.
- Casting of cubes for compression strength at 28 days.
- Maintaining records for consumption of mortar & cement, curing period, joint testing etc.

18.0 QUALITY ASSURANCE:

It is important to understand, what “Quality Assurance Plan” is.

18.1 What it is?

In order that the properties of the completed structure be consistent with the requirements and the assumptions made during the planning and the design, adequate quality assurance measures needs to be taken. The construction should result in satisfactory strength, serviceability and long term durability so as to lower the overall life-cycle cost.

Quality assurance in construction activity relates to proper design, use of adequate materials and components to be supplied by the producers, proper workmanship in the execution of works by the contractor and ultimately proper care during the use of structure including timely maintenance and repair by the owner.

Quality assurance measures are both technical and organizational. Some common cases should be specified in a general Quality Assurance Plan which shall identify the key elements necessary to provide fitness of the structure and the means by which they are to be provided and measured with the overall purpose to provide confidence that the realized project will work satisfactorily in service fulfilling intended needs.

The job of quality control and quality assurance would involve quality audit of both the inputs as well as the outputs. Inputs are in the form of materials for concrete; workmanship in all stages of batching, mixing, transportation, placing, compaction and curing; and the related plant, machinery and equipments; resulting in the output in the form of concrete in place. To ensure proper performance, it is necessary that each step in concreting which will be covered by the next step is inspected as the work proceeds .

Each party involved in the realization of a project should establish and implement a Quality Assurance Plan, for its participation in the project. Supplier’s and subcontractor’s activities shall be covered in the plan. The individual Quality Assurance Plans shall fit into the general Quality Assurance Plan. A Quality Assurance Plan shall define the tasks and responsibilities of all persons involved, adequate control and checking procedures, and the organization and maintaining adequate documentation of the building process and its results.

IS: 456: 2000 (Reaffirmed 2005) is most important document in understanding Quality Assurance, whose supporting item is Durability. From the earlier documents revision of year 2000 is covering many issues, adoption of which supports Quality Assurance. Thus, this revision incorporates a number of important changes. The major thrust in the revision is on the following lines:

- In recent years, durability of concrete structures have become the cause of concern to all concrete technologists. This has led to the need to codify the durability requirements world over. In this revision of the code, in order to introduce

in-built protection from factors affecting a structure, earlier clause on durability has been elaborated and a detailed clause covering different aspects of design of durable structure has been incorporated.

- Sampling and acceptance criteria for concrete have been revised. With tbis revision acceptance criteria has been simplified in line with the provisions given in BS 5328 (Part 4):1990 'Concrete: Part 4 Specification for the procedures to be used in sampling, testing and assessing compliance of concrete'.

18.2 Some of the significant changes incorporated in Section 2 are as follows:

- All the three grades of ordinary Portland cement, namely 33 grade, 43 grade and 53 grade and sulphate resisting Portland cement have been included in the list of types of cement used (in addition to other types of cement).

a) 33 Grade ordinary Portland cement conforming to IS: 269.
b) 43 Grade ordinary Portland cement conforming to IS: 8112.
c) 53 Grade ordinary Portland cement conforming to IS: 12269.

- The permissible limits for solids in water have been modified keeping in view the durability requirements.
  (Table 1 0f IS 456: 2000 shall be referred.)
- The clause on admixtures has been modified in view of the availability of new types of admixtures including super plasticizers.

  (Para 10.3.3 Dosages of retarders, plasticizers and super plasticizers shall be restricted to 0.5, 1.0 and 2.0 percent respectively by weight of cementious materials and unless a higher value is agreed upon between the manufacturer and the constructor based on performance test.)

- In Table 2 'Grades of Concrete', grades higher than M 40 have been included.
- It has been recommended that minimum grade of concrete shall be not less than M 20 in reinforced concrete work (see also 6.1.3).
  (Since, Para 6.1.3 Concrete of grades lower than those given in Table-5 may be used for plain concrete constructions, lean concrete, simple foundations, foundation for masonry walls and other simple or temporary reinforced concrete construction.)

- The formula for estimation of modulus of elasticity of concrete has been revised.
- In the absence of proper correlation between compacting factor, vee-bee time and slump, workability has now been specified only in terms of slump in line with the provisions in IS: 5328 (Parts 1 to 4).
- Durability clause has been enlarged to include detailed guidance concerning the factors affecting durability. (Refer Para 8.2 IS: 456:2005)
- The table on 'Environmental Exposure Conditions' has been modified to include 'very severe' and 'extreme' exposure conditions. This clause also covers requirements for shape and size of member, depth of concrete cover, concrete quality, requirement against exposure to aggressive chemical and sulphate attack, minimum cement requirement and maximum water cement ratio, limits of chloride content, alkali silica reaction, and importance of compaction, finishing and curing.
- A clause on 'Quality Assurance Measures' has been incorporated to give due emphasis to good practices of concreting.

18.3 Quality Assurance Measures

18.3.1 In order that the properties of the completed structure be consistent with the requirements and the assumptions made during the planning and the design, adequate quality assurance measures shall be taken. The construction should result in satisfactory strength, serviceability and long term durability so as to lower the overall life-cycle cost. Quality assurance in construction activity relates to proper design, use of adequate materials and components to be supplied by the producers, proper workmanship in the execution of works by the contractor and ultimately proper care during the use of structure including timely maintenance and repair by the owner.

18.3.2 Quality assurance measures are both technical and organizational. Some common cases should be specified in a general Quality Assurance Plan which shall identify the key elements necessary to provide fitness of the structure and the means by which they are to be provided and measured with the overall purpose to provide confidence that the realized project will work satisfactorily in service fulfilling intended needs. The job of quality control and quality assurance would involve quality audit of both the inputs as well as the outputs. Inputs are in the form of materials for concrete; workmanship in all stages of batching, mixing, transportation, placing, compaction and curing; and the related plant, machinery and equipments; resulting in the output in the form of concrete in place. To ensure proper performance, it is necessary that each step in concreting which will be covered by the next step is inspected as the work proceeds (see also 17).

18.3.3 Each party involved in the realization of a project should establish and implement a Quality Assurance Plan, for its participation in the project. Supplier's and subcontractor's activities shall be covered in the plan. The individual Quality Assurance Plans shall fit into the general Quality Assurance Plan. A Quality Assurance Plan shall define the tasks and responsibilities of all persons involved, adequate control and checking procedures, and the organization and maintaining adequate documentation of the building process and its results. Such documentation should generally include:

- test reports and manufacturer's certificate for materials, concrete mix design details;
- pour cards for site organization and clearance for concrete placement;
- record of site inspection of workmanship, field tests;
- non-conformance reports, change orders;
- quality control charts; and
- statistical analysis

NOTE-Quality control charts are recommended wherever the concrete is in continuous production over considerable period. Proper limits have been introduced on the accuracy of measuring equipments to ensure accurate batching of concrete.

18.3.4 The clause on 'Construction Joints' has been modified.

Construction Joints and Cold Joints are a common source of weakness and, therefore, it is desirable to avoid them. If this is not possible, their number shall be minimized. Concreting shall be carried out continuously up to construction joints,

the position and arrangement of which shall be indicated by the designer. Construction joints should comply with IS 11817: 1886, Reaffirmed 2007.

Construction joints shall be placed at accessible locations to permit cleaning out of laitance, cement slurry and unsound concrete, in order to create rough/ uneven surface. It is recommended to clean out laitance and cement slurry by using wire brush on the surface of joint immediately after initial setting of concrete and to clean out the same immediately thereafter. The prepared surface should be in a clean saturated surface dry condition when fresh concrete is placed, against it.

Delays in concreting can result in cold joints. To avoid cold joints placing should be resumed substantially before the time of initial set. For unusually long delays during concreting, the concrete should be kept live by periodically re-vibrating it.

Concrete should be vibrated at approximately 15 Minutes intervals or less, depending upon job conditions. Concrete should not be over vibrated to the point of causing segregation. Furthermore, if the concrete approach time of initial setting, vibration should be discontinued and the concrete should be allowed to harden

In the case of construction joints at locations where the previous pour has been cast against shuttering the recommended method of obtaining a rough surface for the previously poured concrete is to expose the aggregate with a high pressure water jet or any other appropriate means.

Fresh concrete should be thoroughly vibrated near construction joints so that mortar from the new concrete flows between large aggregates and develop proper bond with old concrete.

Where high shear resistance is required at the construction joints, shear keys may be-provided.

Sprayed curing membranes and release agents should be thoroughly removed from joint surfaces)

18.3.5 The clause on 'Inspection' has been modified to give more emphasis on quality assurance:

To ensure that the construction complies with the design, an inspection procedure should be set up covering materials, records, workmanship and construction.

18.3.6 Tests should be made on reinforcement and the constituent materials of concrete in accordance with the relevant standards. Where applicable, use should be made of suitable quality assurance schemes.

18.3.7 Care should be taken to see that:

a) design and detail are capable of being executed to a suitable standard, with due allowance for dimensional tolerances;
b) there are clear instructions on inspection standards;
c) there are clear instructions on permissible deviations;
d) elements critical to workmanship, structural performance, durability and appearance are identified; and
e) there is a system to verify that the quality is satisfactory in individual parts of the structure (especially the critical ones).

TABLE - 1

RECOMMENDED VALUES OF SLUMP FOR DIFFERENT CONDITIONS OF PLACING

(To enable concrete to be fully compacted)

Placing Conditions	Degree of Workability	Slump (mm)
1	2	3
Blinding concrete; Shallow sections; Pavements using pavers	Very low	See 7.1.1 of IS: 456-2005 Reaffirmed
Mass concrete ; Lightly reinforced sections in slabs, beams, walls, columns ; Floors ; Hand placed pavements ; Canal lining ; Strip footings	Low	25 - 75
Heavily reinforced sections in slabs, beams, walls, columns ; Slip form work; Pumped concrete	Medium	50 – 100 75 - 100
Trench fill; In-situ piling	High	100 - 150
Tremie concrete	Very high	See 7.1. 2 of IS: 456-2005 Reaffirmed

NOTE: - For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete vibrators are not required to be used (see also 13.3 of IS: 456-2000 (Reaffirmed 2005).

TABLE - 2

FIELD-TESTS FOR COMMON MATERIALS OF CONSTRUCTION

Sr. No.	Material	Field test	Procedure
1	Cement	Initial setting time	Take three parts of cement and one part of water. Mix it thoroughly to get a plastic cement paste and fill it up in an empty cigarette tin, observe penetration of an uncut butt of a pencil, Note time since addition of water when resistance to penetration is felt. Normally it should not be less than 30 minutes.
2	Lime	Visual	Colour : dirty white, white, pure white. State of aggregation: Lumpy, powdery, soft and hard. Class C lime: White or pure white color-hard. Quick lime: Lumpy but porous.
		Acid test	Take a tea spoon full of powdered lime and add 10 ml of 50 percent HCl by volume in a test tube, stir with glass rod. Effervescence indicates un burnt lime. Residue after 24 hours indicates inert material, comparison with original volume of lime indicates its proportion. Classification : Class A: Good thick gel at top and inert material at bottom. Class B: Medium thick gel which does not flow when turned. Class C: No gel is formed.
		Ball test	Take lime, add enough water, prepare egg size ball, allow to set for six hours and then place in water Classification : Class A: No expansion. Class B: Little expansion and numerous cracks on surface. Class C: Expansion and disintegration within few minutes.
		Impurities test	Take known weight of lime from kiln, add water, wash it on 250 micron sieve, determine residue weight. Classification : Good – less than 10 per cent residue. Fair – 10 to 20 percent, Poor – above 20 percent.
		Blotting paper test	Prepare thick cream like consistency and leave over night, - Then spread like butter on a blotting paper with knife - Compare it with behavior and performance of standard lime of good quality and judge.
		Workability test	Prepare mortar, apply on rough surface and observe area covered.
3.	Pozzolana	Visual	Clay pozzolana , Colour : well burnt indicated by red copper colour Fineness : feels finer than cement between fingers
4	Sand	Silt content	Take 300-400 cm^3 of sand in a measuring jar, add water to submerge the sand under 3.5 cm depth of water after removal of air, – close the mouth of jar with rubber cork or palm of hand, shake or turn the jar up side down two-three times and allow sand to settle. Silt will settle on sand top. Read depth of silt and compute percentage, of depth of sand which has settled below the silt. Coarseness of sand – gradation can be judged by comparison with bottle specimens, missing fractions indicate gap gradation. Physically deleterious material like coal, clay-balls, mica, lime kankar

Sr. No.	Material	Field test	Procedure
			can be picked out, percentage occurrence can be judged.
5	Metal / gravel	Visual	Identify rock types, judge shape and size-rounded, sub-rounded, flaky, cubical, angular-also percentage of undersize and oversize fractions. Basalt-dolerite, granite, quartzite, hard limestone, siliceous sandstone serve well as road metal. Shale absorb water and give earthy smell, Phyllites, Mica and Schists are flaky and show shining surface. Avoid both.
6	Water	Visual	Examine in glass beaker or test tube for suspended sediment. Use potable water. If brackish or saline use only after testing, check pH with indicator paper.
7	Bricks	Visual	Red copper colour indicates well burnt bricks, check shape, size, frog, weight, presence of nodules, cracks, corners, Metallic sound when struck with each other or by hammer, no damage when allowed to fall free from about five feet on either header or stretcher face.
8	Stones	Visual	Metallic sound when struck with hammer. Iron nail streak indicates softness; observe joints, cracks, cavities, veins, weathered skin and re-entrant angles, check weight, look for fresh fracture when broken with Hammer, rocks like basalt, granite, quartzite, dolerite, compact sandstone and limestone serve well as rubble. Shales, Phyllites and mica Schists are not good. Shales absorb water and give earthy smell.
9	Steel bar	Bending	Free from rust, grease, oil; mild steel can be bent to 'U' shape with mandrel of 2 d . Check diameter and weight per unit length.
10	Tiles	(a) Visual	Check dimensions, colour, expose tiles to sunlight for few days and observe for loss of colour.
		(b) Strength	Saturate the tile with water, support it at the edges, ask one adult to stand in the centre, should not break as wet transverse strength is about 80 kg.
11	Flush door	Adhesion	Cut 150 mm square four specimens from all corners, immerse in boiling water for four hours, examine delamination which should not exceed 50 mm in length and 3 mm in depth.

Sampling

Any material shall be collected as per relevant Indian Standard of materials & shall be sent to laboratory for testing. Frequency of sample requirement is given in this manual. The material shall be reduced to required size as under

1. Coning and quartering:

The material shall be mixed and then scooped into a cone shaped pile. Care shall be taken to drop each scoopful over the same spot. After cone is formed it shall be flattened. Then it is divided into quarters by two lines intersecting at right angles at the centre of cone. The bulk of sample is reduced by rejecting either set of two diagonally opposite quarters. The process is continued till the sample is reduced to required size.

2. Stacks of bricks and tiles:

The stacks shall be divided into sections of approximately equal dimensions. Required samples shall be drawn from each section in a random number.

TABLE - 3

CEMENT OF VARIOUS TYPES & GRADES

IS 4031- (Part 1 & Part 3 to 15), 4031 (Part 2) – 1991 (Reaffirmed 2008), 4032-1985 (Reaffirmed 2009), IS 3535-1986 (Reaffirmed 2009)

Sample: 15 kg.

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
1.	Consistency IS:4031-(Part-4)-1988 (Reaffirmed 2009)	Upto 50 T. - 1 50-100 T. - 2 100 - 200 T - 3 Each sample or as required (IS 3535-1986, Reaff. 2008)	#Vicat apparatus with plunger 10 mm dia. (G type), #Triple beam - Balance	About 30 percent	Determines mixing water requirements for subsequent tests and minimum water requirement for hydration of cement.
2.	Setting time IS:4031-(Part-5)-1988 (Reaffirmed 2009) (a) Initial setting time (b) Final setting time	Each sample or as required	#Vicat apparatus with needle 1 mm diameter (C-Type) #Vicat apparatus with annular attachment (F-type)	Not less than 30 minutes Not more than 600 minutes	Placement compaction is to be completed within initial time. Final setting time limit indicates hardening and gain in strength.
3.	Fineness (a)By sieving IS:4031-(Part-I)-1996 (Reaffirmed 2009) Specific surface by Blain air permeability IS:4031-(Part-2)-1999 (Reaffirmed 2008)	Each Sample or as required Each sample or as required	#90 micron IS sieve and # Balance #Blain air permeability apparatus with accessories	Residue less than 10 percent Not less than 225 m^2/kg for OPC (33, 43& 53 grade) & SRC. Not less than 300 m^2/kg for PPC	More volume retained on sieve indicates cement having undergone moisture attack or inadequate grinding. Less area indicates cement having undergone moisture attack or inadequate grinding.

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
4.	Soundness IS:4031-(Part-3)-1988 (Reaffirmed 2009) (a) Le Chatelier's method (b) Autoclave method	Each sample or as required 1 in 10 samples	#Le Chatelier's apparatus with accessories #Autoclave, Length comparator, 25 x 25 x 250 mm mould and Other accessories.	Expansion not more than 10 mm Expansion not more than 0.80 percent.	More expansion indicates likely excessive and harmful chemical reactions. -do-
5.	Compressive strength IS:4031-(Part-6)-1988 (Reaffirmed 2009)	Each sample or as required sample	#Cube mould (7.07 cm) 50 cm^2 face area, #Baby Vibrator, #Compression Testing Machine, #Curing Tank Etc.	As per Table-4	Higher strength indicates acceptability
6.	Chemical Analysis IS:4032-1985 (Reaffirmed 2009)	1 in 10 sample	#Muffle Furnace, #Oven, #Platinum Crucible, #Chemical Balance.	As per Table-4	

TABLE - 4

VARIOUS TYPES OF CEMENT

Sr. No.	Particular of tests	Acceptance Criteria					Purpose of Testing
		Grade					
		33-G IS 269 : 1989 (Reaff. 2008)	**43-G IS 8112 : 1989 (Reaff. 2009)**	**53-G IS 12269 : 1987 (Reaff. 2008)**	**PPC IS 1489 (Part-I) : 1991, Fly ash based IS 1489 (Part-II) : 1991 Calcined Clay Base(Both Reaff. 2009)**	**SRPC IS 12330 : 1988 (Reaff. 2009)**	
1.	Compressive strength (Min.) N/mm^2 3 days 7 days 28 days	 16 22 33	 23 33 43	 27 37 53	 16 22 33	 10 16 33	
2.	Chemical analysis a. Ratio of % of lime to % of Silica, alumina & iron oxide	Between 0.66 and 1.02	Between 0.66 and 1.02	Between 0.80 and 1.02	--	Not greater than 1.02 and Not less than 0.66	
	b. Ratio of % of alumina to % of iron oxide	Not less than 0.66	Not less than 0.66	Not less than 0.66	--	--	
	c. Insoluble residue %	Not more than 4	Not more than 2	Not more than 2	$\frac{X+4(100-X)}{X}$	Not more than 4	X is the % of declared pozzolana
	d. Magnesia %	Not more than 6	Not more than 6	Not more than 6	Not more than 6	Not more than 6	Higher MgO indicates harmful expansion at a later age
	e. SO_3%	Not more than 2.5 & 3 when C_3A% is 5 or less & > 5 respectively			Not more than 3	Not more than 2.5	Higher SO_3 indicates less durability
	f. Loss on ignition %	Not more than 5	Not more than 5	Not more than 4	Not more than 5	Not more than 5.0	It indicates the freshness of cement
	g. C_3 A%	--	--	--	--	Maximum 5.00	
	h $C_3S = C_4AF + 2C_3$ A%	--	--	--	--	Maximum 25.00	

TABLE - 5

POZZOLANA (CALCINED CLAY, FLYASH)

IS: 1344 – 1981 Reaff 2005, IS: 3812 (Part I & II) – 2003 (Reaff. 2007), IS: 1727-1967 (Reaff 2008)

Sample – 15 kg.

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
1.	Lime reactivity IS: 1727-1967 Reaff 2008	1/100 t IS: 1344-1981, Clause 10.2	#Flow Table, #Mixing Apparatus, #Humidity Cabinet, #5 T Loading Frame #Cube Mould 50 mm	Part1 Min.4.5N/mm^2 Part 2 NA	Less lime reactivity indicates inadequate content of reactive silica to combine with free lime
2.	Particles retained on 45 micron IS sieve (Wet sieving) in percent Max.		#Sieve 45 micron	34 50	
3.	Fineness by specific surface area by Blain's method in m^2/kg	1/100 t. IS 1344-1981, Clause 11.2	#Blains permeability apparatus	320 200	Higher the fineness greater the strength, lesser bleeding and better workability
4.	Compressive strength	1/100 t	#Flow table, #mixing apparatus, #humidity cabinet, #5 t loading frame #cube mould 50 mm X 50 mm	At 28 days minimum 80 percent of the Strength of plain Cement mortar cube. NA At 90 days it shall not be less than that of 28 days strength. NA	Higher strength is acceptable

5.	Chemical analysis IS:1727-1967 Reaff 1999	1/5 Sample	# Muffle furnace, # Platinum crucible # Balance	Constituent	Unburnt Clay (Soil)	Flyash	3812 Part II 2003	
				SiO_2 + Al_2O_3 + Fe_2O_3	Not less than 70 %	Not less than 70%		Silica constituent has to be the major one. MgO causes expansion and disintegration
				SiO_2 (min)	40 %	35 %		
				Na_2O+K_2O (max.)	3 %	1.5 %		
				Water Soluble alkali (max)	1 %	-		
				Loss on ignition (max.)	10 %	12 %	5%	
				CaO (max.)	10 %	-		
				MgO (max.)	3 %	5 %		
				So_3 (max.)	3 %	2.75 %	5%	

TABLE - 6

BUILDING LIME

IS: 712-1984 (Reaffirmed 2005), 6932 (Part 1 to 11) – 1973 (Reaffirmed 2005)

Sample – 10 kg packed tin

Sr. No.	Particular of Test	Frequency	Equipment	Acceptance Criteria	Purpose of testing
1.	Workability IS:6932-(Part-8)-1973 (Reaffirmed 2005)	1/100 T 2/300 T Each sample IS 712-1984, Clause A-2.2.1, Table 3	#Flow table with moulds, #Oven, #Triple beam Balance	Bumps more than 10 and 12 for flow from 11 to 19 cm for C and D types (Hydrated lime & Quick lime)	Determines water requirement for subsequent tests
2.	Fineness IS:6932-(Part-4)-1973 (Reaffirmed 2009)	-do-	#Sieves 2.36 mm, 850 micron, 300 micron	For Hydrated lime No residue on 2.36 mm. 5 percent residue on 300 micron for A, B, E and F Class, Max.10% on IS 212 micron sieve for class C and D, Nil for Class F For quick lime Residue on 850 micron max. 10% for B and F class, 300 micron max. 5% for class C & D	Higher residue indicates inadequate calcination and slaking
3	Setting time IS:6932-(Part-2)-1973 (Reaffirmed 2009)	-do-	#Vicat needle apparatus	For Class A & E (Hydrated lime) Initial – Not less than 2 hours Final – Not more than 48 hours	Placement and compaction is to be completed within initial limit, final limit indicates hardening
4	Compressive strength IS:6932-(Part-7)-1973 (Reaffirmed 2005)	-do-	#Pug mill, #5 cm cube three moulds, #5ton loading frame	A class 1.75, 2.8 N/mm^2 at 14 and 28 days (Hydrated lime) B Class 1.25, 1.75 N/mm^2 at 14 and 28 days (Hydrated & quick lime) E Class 1.00, 1.75 N/mm^2 at 14 and 28 days (Hydrated lime) F Class 1.25, 1.75 N/mm^2 at 14 and 28 days (Hydrated & quick lime)	Hardening is measured in terms of compressive strength which further indicates class of lime

Sr. No.	Particular of Test	Frequency	Equipment	Acceptance Criteria	Purpose of testing
5	Transverse Strength IS:6932-(Part-7)- 1973 (Reaffirmed 2005)	1 in 5 samples	#2.5x2.5x 10cm moulds #Transverse strength tool #5 t loading frame	Min. at 28 days A Class, (Hydrated lime), 1.0 N/mm^2 B class 0.7 N/mm^2 (Hydrated & Quick), E Class 0.7 N/mm^2 (Hydrated), F Class 0.7 N/mm^2 for (Hydrated & quick)	Hardening is measured in terms of Transverse strength which further indicates class of lime
6	Soundness IS:6932-(Part-9)- 1973 (Reaffirmed 2009)	1 in 5 samples	#Le - Chaterlier apparatus	Maximum expansion A&B class 5mm & A&F class 10mm(Hydrated lime)	Excessive expansion indicates higher content of MgO
7	Chemical analysis of Lime IS:6932-(Part-1)-1973 (Reaffirmed 2009) IS : 712 – 1984 (Reaffirmed 2009)	Each sample	#Muffle furnace, #Oven, #Platinum crucible, #Chemical Balance, #Water bath	Analysis percentage Class A B C D E CaO+MgO min 60 70 85 85 25 MgO…max 5 5 5 5 5 $SiO_2+R_2O_2$min, 5 25 15- - - Cementation 0.6 0.3- - - Value to min As per IRC-51-1992 .	Excessive content of MgO causes expansion. Relative percentage of CaO and SiO_2 indicate class of lime
8	Lime content for lime stabilized soil/murram IS:1514-1990 (Reaffirmed 2010) or 712-1984 (Reaffirmed 2009)	a. Before one consignment mixing subject to minimum of 1 test per 5 ton lime b. After 1/250 m^2 mixing		Lime as CaO not less than 50 percent and 60 percent for lime soil and lime fly ash stabilization respectively. No result shall be less than 75 percent of specified lime content Average of 10 samples should not be less than specified lime content	Larger variation indicates inadequate mixing

TABLE - 7

STEEL

IS: 432 (Part 1 & 2) – 1982 (Reaffirmed 2004), IS: 1785 (Part 1 & 2) – 1983(Reaffirmed 2008), IS: 1608-2005, IS: 1599-1985 (Reaffirmed 2006), IS: 1786-2008, IS:1716-1985 (Reaffirmed 2006)

Sample: 100 cm long

Sr. No.	**Particulars of Tests**	**Frequency**	**Equipments**	**Acceptance criteria**	**Purpose of testing**
1.	Tensile, Yield, Elongation IS: 1608-1995 (Reaffirmed 2008)	1 per 40 t	#Universal testing machine, #Vernier calliper, #Centre-Punch, #Hammer	As per table 8	To measure its strength and elasticity
2.	Bend IS: 1599-1985 (Reaffirmed 2006)	1 per 20 t	#Universal testing machine	Round bars, above 25mm dia, should be able to bend without fracture with sides parallel and internal diameter not greater than three times the thickness of the test piece.	It is an indication of carbon content in steel so as to ensure its use in any bent form.
3.	Rebend (In the case of deformed bars only) IS: 1786-2008	1 per 20 t	#For Fe 415 & 500 Universal testing machine, #Mandrels of suitable dia. (5D for bars upto 10mm dia & 7D for bars over 10mm) of 135° and 157½° angle	The bar should withstand without fracture on the bent portion	To evaluate effect of deformation
4.	Reverse bend for ductility (in the case of wires only) IS: 1716-1985 (Reaffirmed 2006)	Sample - Number of coils 3 - 25 4 - 65 5 - 180 7 - 300 10 over 300	#Vice with Jaws of radius 10.0, 12.5, 15.0, 20.0 and 25.0 mm	The wire should withstand without showing any sign of fracture. Permissible defective number in coils tested. 0 in 3 to 4, 1-5 to 7 and 2-10	Measure of its ductility

TABLE - 8

VARIOUS TYPES OF STEEL

Sr. No.	Material	Nominal thickness diameter (mm)	Ultimate Tensile strength Min. ($N/mm^{2)}$	Yield stress Min. ($N/mm^{2)}$	Elongation, Percent Min. Gauge length $5.65\sqrt{A}$
1.	Mild steel and medium Tensile steel Bars and Hard-Drawn Steel wire for concrete reinforcement IS: 432(Part I) – 1982 (Reaffirmed 2009) Mild steel and medium tensile steel bars IS:432(Part-2)-1982 (Reaffirmed 2009), Hard drawn steel wire	Mild steel gr.I 0 – 20 20 – 50 Mild steel gr.II 0 – 20 20 – 50 Medium Ten. Steel 0 – 16 16 – 32 32 – 50	410 410 370 370 540 540 510	250 240 225 215 350 340 330	23 23 23 23 20 20 20
2.	High strength deformed steel bars and wires for concrete Reinforcement / Thermo Mechanical Treated (TMT Bar) IS: 1786-1985 (Reaffirmed 2008)	All sizes	Grade Fe 415 :485 Fe 500 :545 Fe 550 :585	415 500 550	14.5 Yield stress Indicates 12.0 proof stress at 0.2 8.0 percent of the original gauge length
3.	Plain Hard-Drawn steel wire for prestressed concrete IS: 1785 (Part I) – 1983 (Reaffirmed 2008) Cold Drawn Stress – Relieved Wire (Second Revision)	2.50 3.00 4.00 5.00 7.00 8.00	2010 1865 1715 1570 1470 1375	85 Percent of the minimum specified tensile strength	2.5 2.5 3.0 4.0 4.0 4.0 Elongation after fracture over a Gauge length 200 mm
4.	Plain Hard-Drawn Steel Wire for prestressed concrete IS: 1785 (Part II) – 1983 (Reaffirmed 2008) As – Drawn Wire (First Revision)	3.00 4.00 5.00	1765 1715 1570	75 Percent of the minimum specified tensile strength <20 mm / 20-40 mm / >40 mm	
5	Steel for General structural purposes – specification IS: 2062 – 2006 Steel plates, strips, sections, flats, Bars etc.	Gr. A Fe 410 WA (All sizes) Gr. B. Fe 410 WB (All sizes) Gr. C. Fe 410 WC (All sizes)	410 410 410	250 / 240 / 230 250 / 240 / 230 250 / 240 / 230	23 23 23

TABLE - 9

BUILDING STONE

Sample 2 Rubble 25 x 25 x 25 cm

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
1	Specific gravity (apparent) &water absorption IS: 1124-1974 (Reaffirmed 2008)	1/week	#Cyl. Meas. Jar (100ml,100ml) #Glass vessel #Balance,3kg (Acu. 1gm) #Desicator #Oven	Absorption: Not more than 5% for rubble masonry. Not more than 2.5% for sand stone flooring	Lesser the water absorption higher the durability and lesser the weathering. For dams higher porosity causes more leakage
2	Specific gravity (true) IS:1122-1974 (Reaffirmed 2008)	1/week	#Ana.Balance #Sp Grv Bottle #Thermometer #Dry oven #Weighing bottle #Desicator	As per relevant specifications	Higher the specific gravity more is the durability & economy
3	Porosity IS:1124-1974 (Reaffirmed 2008)	1/week	#Cyl. Meas. Jar (100ml,100ml) #Glass vessel #Balance,3kg (Acu. 1gm) #Desicator #Oven	As per relevant specifications	
4	Compressive strength IS: 1123(Part – I)-1975 (Reaffirmed 2003)	2 sets of tests per working season	#Rock cutting machine #200 t compression testing machine	As per Table 1 of IS 1123-1975	Indicates load carrying capacity & integrity
5	Transverse strength IS:1121(Part-2)1974 (Reaffirmed 2008) IS: 3622-1977	1/800 Nos.	#5 ton loading frame, #Transverse block assembly	Sand stone-70 kg/cm^2	Ensures least breakage
6	Shear strength IS: 1121(Part-4)1974 (Reaffirmed 2008)	2 sets of tests per working season	#Shear test equipment	As per Table 1 of IS Code 1123-1975	Ensures integrity against vertical sustained load.
7	Weathering IS:1125-1976 (Reaffirmed 2008)	2 sets of tests per working season	#Balance enclosed type (1kg ,0.01gm)	As per relevant IS specification	To measure durability & strength

TABLE 10

COARSE AGGREGATE (METAL, GRAVEL ETC.)

IS: 2386-1963 (Reaffirmed 2007) (Part 1 to 8), IS: 383-1970 (Reaffirmed 2007)

Sample: 100 kg.

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
1.	Gradation: IS: 2386 (Part-1)-1963 (Reaffirmed 2007)	1/150 m3 for concrete or as per specification	#Set of coarse sieves 80mm to 4.75mm, #Balance, (Accuracy 0.1% of test sample)	As per relevant specifications' provision	Gradation governs the bulk density and void content.
2.	Sp. gravity & water absorption IS: 2386(Part-3)-1963 (Reaffirmed 2007)	2/season	#Wire basket, #Balance (3 kg, accuracy 0.5gm) #Oven, 100 – 110 ^{0} C	As per relevant specifications' provision Sp. gravity generally 2.5 to 3.0 and water absorption 1 to 1.5%	Higher the specific gravity, higher the density and greater the durability.
3	Flakiness & elongation indices IS:2386-(Part-1)-1963 (Reaffirmed 2007)	As per specification	#Balance (Accuracy 0.1%) #Length gauge, #Thickness gauge, #Sieves	As per design	Flaky material needs more sand, water & cement for same strength.
4	Impact value IS: 2386 (Part-4)-1963 (Reaffirmed 2007)	2/season	#Impact testing machine, #Tamping rod #Balance (500 gm, Accuracy 0.1 gm) #Sieves 12.5, 10 & 2.36 mm #Hammer (13.5 -14 Kg) Oven , 100 – 110 ^{0} C	As per IS: 383-1970 Concrete-wearing-surface-30% max. Overlaid surface 45%max.	Lower impact value gives better performance in facing successive moving loads
5	Abrasion value IS: 2386 (Part-4)1963 (Reaffirmed 2007)	2/season	#Los Angeles abrasion machine, #Sieve 1.7 mm	As per IS: 383-1970 Concrete- Wearing surface-30%max. Over laid surface-50 % max.	Higher abrasion value indicates more wear &tear &higher cost of repairs & maintenance

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
6	Soundness IS: 2386 (Part-5)1963 (Reaffirmed 2007)	2/Season	#Sieves (Sq. as per IS460-1962) #Oven 100 – 110 ^{0} C and #Balance (500 gm, Accuracy 0.1 gm)	As per-IS:383-1970 Concrete with coarse aggregates. Loss with Na2SO4 -12%max. Loss with $MgSo_4$ - 18%max.	Higher loss indicates less ability of the stones to withstand effect of freezing & thawing
7	Alkali reactivity IS:2386-(Part-7)1963 (Reaffirmed 2007)	2/Season	#Scales #Weights #Photometer #Analytical Balance #Crushing equipment #Grinding equipment #Sieves IS-460: 1962 #Reaction container #Temp. bath	As per Sc/Rc curve or relevant specifications provisions	Deleterious aggregate cause disintegration of concrete
8	Petrografic examination IS:2386(Part-8)-1963 (Reaffirmed 2007)	2/Season	#Microscope, #Hammer, #Balance 2 Kg, Sensitive 0.1 gm.	Relevant specifications provision or deleterious constituents not more than 5% including silt content	Deleterious material beyond 5% leads to chemical reactions, cracking of concrete etc.

TABLE 11

FINE AGGREGATE (SAND)

IS: 2386-1963 (Part - I to 8) (Reaffirmed 2007), IS:383-1970 (Reaffirmed 2007)

Sample 20 kg

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
1	Gradation Fineness modulus IS: 2386-(Part-1)1963 (Reaffirmed 2007)	1/150m3 or as per requirements of the relevant specification	#Fine sieve set of 4.75, 2.36, 1.18 mm & 600, 300, 150, 75 micron, #Lid, #Pan and #Balance (Accuracy 0.1 % weight of sample)	As per relevant specification provision and looking to the purpose of the use For concrete IS:383-1970 Masonry mortar IS: 2116 –1980 Plaster IS:1542-1992	Poor gradation & lower F.M. give low strength, demand more water for mixing
2	Specific gravity & water absorption IS: 2386-(Part-3)1963 (Reaffirmed 2007)	2/Season	#Pycnometer, #Oven, #Two pan # Balance, 2 Kg (0.5 % sensitive)	As per relevant specifications & design	Lower specific gravity & higher water absorption decrease durability & density & increase shrinkage
3	Silt content IS: 2386-(Part-1)1963 (Reaffirmed 2007)	1/150m3	#75 micron sieve, #Balance, #Oven	Not more than 3% or the relevant specification's provision	Higher silt content reduces strength, increases water requirement & inhibits bond
4	Alkali reactivity IS: 2386-(Part-1)1963 (Reaffirmed 2007)	2/Season	#Reactivity container, #Water bath, #Balance	As per Sc/Rc curves.	Amorphous silica, glass, mica content lead to chemical disintegration
5	Petrographic examination IS: 2386-(Part –8)1963 (Reaffirmed 2007)	2/season	#Microscope, #Balance, 2 Kg (Sens. 0.1 gm)	Relevant specification's provision or deleterious constituents plus silt content not more than 5%	Deleterious material beyond 5% affects durability

TABLE 12

BUILDING BRICKS

IS: 1077 - 1992 Reaffirmed 2007, IS: 3495 (Part 1 to 4) - 1992 Reaffirmed 2007

Sample: 25 bricks.

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance Criteria	Purpose of Testing
1.	Dimension and tolerance IS:1077-1992 (Reaffirmed 2007)	50 bricks from 50,000 (20 bricks)	#Steel tape	For 19 x 9 x 9 cm Length 4520 to 4680 mm (for 20 bricks) Width 2160 to 2240 mm Height 1360 to 1440 mm	Uniform bricks need minimum thickness of joint and hence less mortar. Bond improves.
2.	Water absorption IS : 3495 (Part-2) 1992 (Reaffirmed 2007)	5 bricks	#Oven, #Two pan #Balance, #Water tank.	Not more than 20 percent or as specified in relevant specifications.	More absorption means inadequate burning and less durability. Excess absorption leads to dampness, leaching of salt.
3.	Compressive strength IS: 3495-(Part -1)-1992 (Reaffirmed 2007)	5 bricks	#Comp. testing machine	Not less than 3.5 N/mm^2 or as specified in relevant specifications.	Strong and durable masonry is ensured. More load can be laid on the wall. High strength bricks are ideal for hollow brick masonry.

4.	Efflorescence IS : 3495-(Part-3)-1992 (Reaffirmed 2007)	5 bricks	#Glass dish or porcelain or stoneware dish	Classified as Nil ---------- Slight ---------- Moderate ---------- Heavy ---------- Serious	No deposition of salt on Bricks. ---------- Thin deposit of salt covering not more than10% of exposed brick area. ---------- Deposit of salt cover Ing upto 50 % of the exposed brick area. ---------- Heavy deposit of salts covering 50% or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface' ---------- Heavy deposit of salts accompanied by powdering, flaking of the exposed surfaces	Excess efflorescence causes disintegration and defacement.
5.	Chemical analysis of soil for suitability of preparing bricks. IS : 2117 - 1991 (Reaffirmed 2007)	Each soil sample (5 bag)	#Chemical #Balance, #Furnace, #Water Bath.	CaO+MgO. Water soluble Salts	Not more than 1% for alluvial and not more than 15 % for other than alluvial. maximum 1 %	Initial indication of suitability of soil for bricks.

TABLE 13

ACID RESISTANT BRICKS

IS: 4860 – 1968 Reaffirmed 2006

Sample – 15 Bricks

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
1	Water absorption IS:4860-1968 (Reaffirmed 2006)	IS : 4860	#Oven, #Balance	Class I – Not more than 2 % Class II – Not more than 4 %	Indicates integrity of bricks and masonry or lining
2.	Compressive strength IS:4860-1968 (Reaffirmed 2006)	IS : 4860	#200 t Compression testing machine	Class I – Not less than 700 kg/cm^2 Class II – Not less than 500 kg/cm^2	Strength and durability are ensured
3.	Flexural strength IS:4860-1968 (Reaffirmed 2006)	IS : 4860	#100 ton compression testing machine	Class I – Not less than 100 kg/cm^2 Class II – Not less than 70 kg/cm^2	Strength and durability are ensured

TABLE 14

CEMENT CONCRETE FLOORING TILES

IS: 1237 - 1980 (Reaffirmed 2006)

Sample - 18 Nos

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance Criteria	Purpose of Testing
1.	Water absorption	6/2000 tiles	#Balance, #Oven, #Water Tank	Not more than 10 percent.	Ensures dryness of flooring and durability.
2.	Transverse strength	6/2000 tiles	#5 t loading frame, #transverse apparatus	Shall not be less than 3 N/mm2	Capacity to withstand load if support is lost
3.	Abrasion	6/2000 tiles	#Tile abrasion machine, #Stone cutting machine.	Average wear shall not exceed 3.5 mm - wear on any individual specimen shall not exceed 4.0 mm	Lower the abrasion value, higher the durability and lower the maintenance.
4.	Size	-do-	#Steel tape	The size of cement concrete flooring tiles shall be as follows. L B T mm mm mm 200 200 20 250 250 22 300 300 25	
5.	Tolerances	-do-	#Steel foot rule	Length or Breadth (+/-) 1 mm Thickness + 5 mm In addition, the difference in thickness between the thickest and thinnest tile in the sample shall not exceed 3 mm	

TABLE 15

LOW DENSITY POLYETHYLENE FILM (LDPE)

IS:2508-1984 Reaffirmed 2008

Sr. No.	Particulars of Tests	Frequency		Equipments	Acceptance Criteria	Purpose of Testing
1	Measuring thickness	Lot size 1 2-15 6-40 41-65	No.of samples 1 2 3 5	#Micrometer or thickness gauge meter	Up to & including 40µ : (±) 25% Above 40µ : (±) 20%	Uniformity, assurance of performance, economy
2	Tensile strength	-do-		#Tensile Testing Machine	Tensile strength MN/m^2(min) a) length wise 11.77 (120 kgf /cm^2) b) cross wise 8.33 (25 kgf/cm^2)	The measure of tensile strength
3	Elongation 75 micron above	-do-		#Tensile Testing Machine	Elongation %(min) a) length wise 200 b) crosswise 400	The measure of film elasticity, durability
4	Impact test	-do-		#Impact Tester	Impact failure load shall not be less than 1.20N for 100µ LDPE film (N=gf)	To examine resistance to impact

TABLE 16

FLUSH DOOR

IS: 2202 (Part – I) – 1991 (Reaffirmed 2009)

Sample: 2 Nos.

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance Criteria	Purpose of Testing
1.	End immersion	IS : 2202 –I-1991	#Curing tank, #Steel foot rule	No delamination	To check the quality of glue resin used in the flush door, so as to ensure durability
2.	Adhesion	IS : 2202 –I-1991	#Water heater, #Vernier caliper	No delamination in the plywood 3 pieces out of 4 should not have single delamination measured continuously more than 50mm in length and 3mm in depth	To know the strength of adhesion in flush door and hence durability

Note: In case of solid core type flush door when physical tests are not satisfied, two additional shutters for each unsatisfactory shutter are tested for particular test and all shutters ought to satisfy the requirement of test.

TABLE 17

CEMENT CONCRETE

IS: 456-2000 (Reaff 2005) IS: 516-1959 (Reaff 2008), IS: 1199-1959 (Reaff 2008)

<table>
<tr><th>Sr. No.</th><th>Particulars of Tests</th><th colspan="2">Frequency</th><th>Equipment</th><th colspan="2">Acceptance criteria</th><th>Purpose of testing</th></tr>
<tr><td>1.</td><td>Mixer efficiency IS:4634-1991 (Reaff 2005)</td><td colspan="2">At start of job and occasionally for each batching plant/mixer- Requirement of work</td><td>#Container # Mixer, #Weighing Balance etc.</td><td colspan="2">Maximum unit weight variation within batch 0.8 percent from average. Maximum average variability 0.6% for 3, 0.5% for 6, 0.4% for 9, 0.3% for 10 batches</td><td>Ensures intimate homogeneous mixing and uniform dispersal of cement paste</td></tr>
<tr><td>2.</td><td>Workability IS: 1199-1959 (Reaff 2008)</td><td colspan="2">Daily for each shift at plant and site</td><td>#Slump cone, #Plate #Tamping rod, #Steel tape</td><td colspan="2">It should be as per Indian Standards, IS -456: 2005</td><td>Ensures proper placement and minimum voids</td></tr>
<tr><td>3.</td><td>Yield & Unit weight IS: 1199 – 1959 (Reaff 2008)</td><td colspan="2">Occasionally or as directed by Engineer in charge</td><td>#0.01 /0.02 m^3 #container, #Weighing Balance (Senstive 0.01 Kg) Tamping rod</td><td colspan="2">$\pm$ 2% from design or as specified in the specification</td><td>Useful for determining and controlling cement level</td></tr>
<tr><td>4.</td><td>Air content IS: 1199-1959 (Reaff 2008)</td><td colspan="2">-do-</td><td>#Air entrainmeter capacity 0.005 m^3, 0.01m^3, 0.1 m^3 with access.</td><td colspan="2">$\pm$ 1% from design or as specified in the specification</td><td>Higher air content causes reduction in strength</td></tr>
<tr><td rowspan="6">5.</td><td rowspan="6">Compressive strength IS: 516-1959 (Reaff 2008)</td><td colspan="2">As per IS 516 and as specified in the relevant specification</td><td rowspan="6">#2000 KN compression testing machine, #15 cm cube mould, #Vibrating Table</td><td colspan="2">As per relevant specifications provision</td><td rowspan="6">To evaluate the quality of concrete, its acceptability. If not acceptable measures to improve are tried.</td></tr>
<tr><td>Qty of concr-ete work in m^3</td><td>No. of samp-le</td><td>Grade designation</td><td>Specified characteristic compressive strength of 150 mm cube 28 days, N/mm^2 Approx</td></tr>
<tr><td>1-5</td><td>1</td><td></td><td></td></tr>
<tr><td>6-15</td><td>2</td><td>M 15</td><td>15</td></tr>
<tr><td>16-30</td><td>3</td><td>M 20</td><td>20</td></tr>
<tr><td>31-50</td><td>4</td><td>M 25</td><td>25</td></tr>
</table>

Sr. No.	Particulars of Tests	Frequency		Equipment	Acceptance criteria		Purpose of testing
		51 & above	4 plus one additional sample for each additional 50 m^3 or part there of		M 30 M 35 M 40 Upto M80 in increment of 5	30 35 40 Upto 80 in increment of 5	
	Note :	1) At least one sample is taken from each shift 2) Three test specimen shall be made for each sample for testing at 28 days. Additional samples may be required for various purpose such as to determine strength of concrete at 7 days or at the time of striking the form work or to determine duration of curing or to check the testing error.			(A) The concrete shall be deemed to comply with the strength requirements when both the following condition are met : a) The mean strength determined from any group of four consecutive test results compiles with the appropriate limits in col. 2 of Table below b) Any individual test result complies with the appropriate limits in col 3 of Table below		
					(B) If the concrete is deemed not to comply pursuant to (A) above the structural adequacy of the parts affected shall be investigated (see clause 17 of IS:456-2000) and any consequential action as needed shall be taken		
					Note: Standard deviation based on test strength of sample Number of test results of samples:		
					a) The total no. of test strength results of samples required to constitute an acceptable record for calculation of standard deviation shall be not less than 30. Attempts should be made to obtain the 30 samples test results as early as possible, when a mix is used for the first time. b) In case of significant changes in concrete (example change in material) than standard deviation value shall be separately calculated.		

Sr. No.	Particulars of Tests	Frequency	Equipment	Acceptance criteria			Purpose of testing
				Specified Grade	Mean of Group of 4 Non-Overlapping Consecutive Test Results in N/mm^2	Individual Test Results In N/mm^2	
				M 15	≥ fck + 0.825 x established standard deviation (rounded off to nearest 0.5 N/mm^2) or fck + 3 N/mm2 whichever is greater	≥ fck -3 N/mm^2	
				M 20 or above	≥ fck + 0.825 x established standard deviation (Rounded off to nearest 0.5 N/mm^2) or fck + 3 N/mm^2 whichever is greater	≥ fck - 3 N/mm2 (Amendment No.3, Aug. 2007)	
				NOTE: In the absence of established value of standard deviation, the values given in Table 8 of IS:456-2000 may be assumed, and attempt should be made to obtained results of 30 samples as early as possible to establish the value of standard deviation.			

TABLE 18

R.C.C. PRECAST CONCRETE PIPES

IS:458-2003(Reaffirmed 2008) & IS:3597-1998 Reaffirmed 2003)

Sample-4 Nos

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance Criteria	Purpose of Testing
1	Dimension test IS:458-2003 (Reaffirmed 2008)	As per table 15 of IS:458 or as specified in the relevant specification	#Steel tape	Tolerance as specified in IS:458 or as per the relevant specification	Uniformity, economy, performance
2	Hydrostatic test IS:3597-1998 (Reaffirmed 2008)	As per table 15 of IS:458 or as specified in the relevant specification	#Hydrostatic testing machine & #Pump	No leakage sign should be seen when the specimen is filled with water & pressure of 0.7.kg/cm2 is applied &maintained for the specified time	To know the leakage at certain pressure. To ensure water tightness
3	Three edge bearing test IS:3597-1998 (Reaffirmed 2008)	As per table 15 of IS:458 or as specified in the relevant specification	#Testing machine with accessories, #Pressure applying device, #Crack measuring gauge	No crack should develop up to the load to produce 0.25 mm crack as specified in IS:458 or the relevant specifications	Structural safety against bridging on sub grade
4	Absorption test IS:3597-1998 (Reaffirmed 2008)	-	#Oven convection type 110-115^0 C #Balance (Accu. 0.1 gm)	a) Absorption in the first 10 minutes shall not exceed 2.5 percent of the dry mass b) Total absorption at the end of 24 hrs. shall not exceed 6.5 percent of the dry mass (IS:458-2003)	To know the porosity of the pipe material

Note: 1) The concrete for non-pressure pipes shall have a minimum cement content of 360 kg/m^3 & minimum comp. Strength of 20 N/mm^2 at 28 days. For pressure pipes minimum cement content 450 kg/m^3 and minimum comp. strength of 20 N/mm^2

2) Reinforcement used for the manufacture of RCC pipes shall be as per relevant specifications of steel

TABLE 19

MASONRY MORTAR

IS : 2250 – 1981 (Reaffirmed 2005)

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance Criteria	Purpose of Testing
1.	Consistency (Workability) IS:2250-1981 (Reaffirmed 2005)	Each working day	#Standard cone apparatus, #Flow table	As specified in the relevant specification	Ensures proper placement and minimum voids.
2.	Compressive strength IS:8605:1977 (Reaffirmed 2009)	3 Cubes / 100 m^3 or / day whichever is more for each age	#Compression testing machine, #5 x 5x5 cm Cube Mould, #Mixing Bowl.	1 in 5 samples may fall below specified strength upto 80 percent.	Governs strength and durability.
3.	Permeability IS: 3085-1965 (Reaffirmed 2007)	1 / week	#Permeability apparatus #Water Reservoir	As specified in the relevant specification	Ensures water tightness
4.	Water Retentivity IS:2250-1981 (Reaffirmed 2005)	When mortar is to be used with masonry unit which has got high suction characteristics.	#Water Retentively Apparatus, #Straight Edge, #Mixing Bowl, #Flow Table.	Flow after suction in the test shall not be less than 10 percent of the flow before suction.	To know the ability of mortars to retain water against suction and evaporation.
5.	Air content	1/50 m^3	#Air Entrainmeter	$\pm$ 1 per cent from design	Higher air content causes reduced strength.
6.	Yield & Unit weight	1/50m^3	#0.03m^3 containers	$\pm$ 2 per cent from design cement level unit volume of mortar or as specified in relevant specification	Useful for determining and controlling cement level.
7.	In situ permeability	As per specification	#Drilling machine, #In-situ permeability apparatus with pressure gauge and packers.	As per design	Ensures water tightness.

TABLE 20

SEALING COMPOUND

IS:13143-1991(Reaffirmed 2009), 5256-1992 (Reaffirmed 2008)

Sample – 3 kg.

Sr. No.	Particular of Test	Frequency	Equipment	Acceptance Criteria	Purpose of Testing
1	Softening Point IS:1205-1978	As per specification	#Ring and Ball apparatus, #Bath & Stirrer #Thermometer	It shall not be less than 85° C	For determination of softening point of sealing compound
2.	Penetration at 25 °C 100 g 5%, 1/10 IS:1203-1978		#Container dia 55mm – 70mm, depth 35 – 45 mm. #Needle #Water bath #Peneteration apparatus #Thermometer #Time device	Minimum – 15, Maximum – 30	To determine the grade of sealing compound
3.	Flash Point IS:1209-1978		#Pensky-Martens closed Tester	Minimum 200^0 C	To determine the flash point & fire point of sealing compound
4.	Pour Point IS:1834-1984 (Reaff 2005)		#Container #Heating unit	Minimum temperature at which the sample will pour readily	To ensure viscosity & workability
5.	Increase in softening point after heating to 20 ° C above the maximum pour point for 3 hrs. IS:1205-1978		#Ring & Ball apparatus, #Bath & Stirrer	Maximum 5 ° C	To determine increase in softening point of sealing compound
6	Extensibility at 0°C IS:1834-1984 (Reaff 2005)		#Test block #Metal jig	Minimum 6 mm at 0^0 C	Determination of capacity to extend
7	Water content IS:1211-1978		#Dean & Stane Assembly, #Heater #Flask #Receiver	Maximum 0.5 percent by weight	To determine water content of sealing compound

TABLE 21

WATER (FOR CONCRETE & MORTAR)

IS: 456 – 2000 (Reaffirmed 2005)

Sample 1 liter

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
1.	Chemical Analysis.	Once for approval of source	#Muffle Furnace, #Water Bath #Oven, #PH Meter & #Platinum Crucible.		Chemical suitability & stability
	pH			May be taken between 6 to 8.	pH lower than 6 is acidic, leads to corrosion, loosens bond. pH more than 8 causes excessive leaching.
	Chlorides (mg / l) IS : 3025 (part-32) – 1988 (Reaffirmed 2009)			2000 mg/l for plain concrete & 500 mg/l for RCC work max.	Higher chlorides cause corrosion.
	Organic matter (mg/l) IS : 3025 (part - 18) - 1984 (Reaffirmed 2006)			200 mg/l max.	Excess organic matter may adversely affect the hardness of concrete, may stain the concrete.
	Inorganic matter (mg/l) IS : 3025 (part-18)- 1984 (Reaffirmed 2006)			3000 mg/l max.	Excess inorganic matter causes efflorescence.
	Sulphate (mg/l) IS : 3025 (part-24) - 1986 (Reaffirmed 2009)			400 mg/l max.	Excess sulphate attacks calcium carbonate to form calcium alumino Sulphate which is weak, expands and disintegrates concrete.
	Suspended matter IS : 3025 (part - 17) - 1984 (Reaffirmed 2006)			2000 mg/l max.	
	Neutralization of alkalinity IS : 3025 (part-23) - 986 (Reaffirmed 2009)			25 ml with 0.02 N H_2SO_4 max.	
	Neutralization of acidity IS : 3025 (part-22) - 1986 (Reaffirmed 2009)			5 ml with 0.02 N NaOH max.	

Note: In case of doubt regarding development of strength, the suitability of water for making concrete shall be ascertained by the compressive strength and initial setting time tests specified in 5.4.1.2 & 5.4.1.3 of IS : 456 - 2000 (Reaffirmed 2005).

TABLE 22

CURING COMPOUND

ASTM C-156-2007, C-309-2007, E- 97-1990

Sample: 1 litre

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance Criteria	Purpose of Testing
1	Water retention test ASTM C-156-2007	1lit.per 1000 lit. or as specified in the relevant tender specification	#Mould, #Gun Sprayer, #Balance, #Humidity Control #Oven etc.	Water loss after 72 hrs.-not more than 0.55 kg/m^2	To find out the ability to reduce moisture loss during the early hardening period of concrete
2	Reflectance test ASTM E-97-1990	-do-	#Gloss Reflectometer	Shall exhibit a daylight reflectance not less than < 60 %	To find out reflectance value of white pigment based curing compound
3	Drying time test ASTM C-309-2007	-do-	#Mould, #Gun sprayer, #Humidity control #Oven	a) Dry to touch not more than 4 hrs. b) After 12 hrs. the compound shall not be tracky or track off the specimen	To know the drying time requirement

TABLE 23

PVC WATER STOPS

IS: 8543-(Part 4)-1984 Reaffirmed, 2003 IS: 12200-2001 Reaffirmed 2008, ASTM D 638-1991, D 412-1992, D 2240-1991

Sample: 1.5m long – 3 pieces

Sr. No.	Particulars of Tests	Frequency	Equipments	Acceptance criteria	Purpose of testing
1.	Tensile Strength IS: 8543-(Part 4 / Sec.1) -1984 (Reaffirmed 2003)	Per lot of 45m or as per specified in specification	#Tensile Strength Testing Machine with Accessories	Shall not be less than 116 kg/cm^2	To measure its strength
2.	Ultimate elongation IS: 8543-(Part 4 / Sec.1)-1984 (Reaffirmed 2003)	-do-	-do-	Shall not be less than 300 percent	To measure its elasticity
3.	Tear resistance	-do-		Shall not be less than 49 kg/cm^2	To disallow tearing
4.	Stiffness in flexture	-do-		Shall not be less than 24.60kg/cm^2	
5.	Accelerated Extraction				
	i) tensile strength	-do-	#Tensile Strength Testing Machine with Accessories	Shall not be less than 105 kg/cm^2	To measure strength
	ii) Ultimate elongation	-do-	-do-	Shall not be less than 250 percent	To measure its elasticity, Durability
6.	Effect of alkali at 7 days				
	a) Change in weight %	-do-		+ 0.10 percent max.	
	b) Hardness change	-do-		+ 5.0 point	To measure strength
7.	Effect of alkali after 28 days				
	a) Weight increase			0.40 percent max.	
	b) Weight decrease			0.3 percent max.	
	c) Change in dimension			+ 1 percent	
8.	Durometer Hardness			+ 1 percent shore “D”	

Note: IS: 8543 (Part 4-Sec I) is made inactive by IS authority. In case PVC water stops are to be used, the reference to above table may be made suitably.

TABLE 24

ADMIXTURE FOR CONCRETE

IS: 9103-1999 Reaffirmed 2008

Sample : 1 Litre

Sr.No.	Particulars of test	Freq.	Equip.	Acceptance Criteria				Purpose of Testing
				Acceltng. Admix.	Retarding Admix.	Water reducing Admix.	Air entrain Admix.	
1.	Water content of control sample	1/1000 lit.	#Oven with Thermo.	-	-	95	-	To evaluate % of water
2.	Setting time allowable deviation from control sample in hrs.		#Vicat Apparatus with initial & final setting needle					To know the suitability in concrete / mortar in setting time
	Initial (max/min)			-3 max.	+3 max.	± 1 max.	-	
				-1 min.	+1 min.	-	-	
	Final (max/min)			-2 max.	+3 max.	± 1 max.	-	
				-1 min.	+1 min	-	-	
3.	Comp. Strength % of control sample (min) Days 3 7 28		#C.T.M machine	125 min. 100 min. 100 min.	90 min. 90 min. 90 min.	110 min. 110 min. 110 min.	90 min. 90 min. 90 min.	To know the suitability in concrete / mortar in strength
4.	Flexur. Streng. % of control sample (min) Days 3 7 28		#Flexural Testing machine	110 min. 100 min. 90 min.	90 min. 90 min. 90 min.	100 min. 100 min. 100 min.	90 min. 90 min. 90 min.	To know the suitability in concrete/mortar in strength
5.	Length change percent increase from control sample 28 Days 6 Months 1 Year		#Length change compare.	0.010 max. 0.010 max. 0.010 max.	0.010 max. 0.010 max. 0.010 max.	0.010 max. 0.010 max. 0.010 max.	0.010 max. 0.010 max. 0.010 max.	To know the shrinkage in mortar / concrete
6.	Bleeding percent increase over control sample		#Pipette, #Temping Bar, dia 16 mm, 600 mm long #Cylinder	5 max.	5 max.	5 max.	5 max.	To determine relative quantity of mixing water that will bleed from a sample.

Name of Division:
Name of Sub Division:

O.K.CARD FOR CEMENT CONCRETE MIX (AT BATCHING PLANT)

Name of work : Date :
Location of plant : Grade of Concrete : M
Date of calibration of plant : Proportion by weight as per Mix design :
Location of Placing Concrete :

Cement:..... ...kg/m^3
Sand:..... …. kg/m^3
Coarse Aggregate:..... ... kg/m^3
Water:..... ... litre
W/C ratio:.....

1. Whether all ingredients of concrete are tested? :

Cement	Coarse Aggregate	Sand	Water	AEA etc.
Yes / No	Yes / No	Yes / No	Yes / No	Yes / No

2. Whether quality of coarse aggregate are as per specifications Yes / No
3. Whether gradation & size of coarse aggregate are as per specifications and mix dn? Yes / No
   (Give % oversize and undersize):
4. Quality of sand: F.M. / Silt
5. Type and brand of cement: PPC / OPC
6. A.E.A.: Make & %
7. Water: Quality
8. W/C ratio
9. Slump value : (a) Mix design ..... mm
   (b) Observed at plant ..... mm
10. a. Total m^3 batched ..... m^3
    b. Total m^3 placed ..... m^3
11. (a) No. of cube set required as per frequency laid down in tender / IS :
    (b) No of cube set casted at plant site:
    (One set means 6 cubes; 3 for 7 days & 3 for 28 days)
12. Instruction of inspecting officer, if any?

Signature of contractor Signature of A.E. / A.A.E. (Construction) Signature of D.E.E.

Signature of D.E.E. / A.E. / A.A.E. (Q.C. Sub Dn.) Signature of Inspecting Officer

Name of Division:

Name of Sub Division:

O.K.CARD FOR CONCRETING AT THE STRUCTURE UNDER CONSTRUCTION

Name of work :

Name of Structure :

Grade of Concrete :

Location :

Proportion by weight as per Mix design :

Details of Component :

Cement:..... kg/m^3

Sand:..... kg/m^3

Coarse Aggregate..... kg/m^3

Date of Start :

Date of Completion :

Date of Completion :

Water:..... litre

W/C ratio:.....

A. SURFACE PAEPARATION :

1. Whether the cleaning of foundation is done as specified? Yes / No
2. Whether dewatering arrangement adequate? Yes / No
3. Whether foundation mapping is done? Yes No / N.A.
4. Whether the surface to receive the concrete is prepared as specified? Yes / No

B. REINFORCEMENT:

5. Whether testing of reinforcement is done? Yes / No
6. Whether cleaning of reinforcement is done? Yes / No
7. Whether the checking of reinforcement done for
   - (a) Cover Yes / No
   - (b) Spacing Yes / No
   - (c) Binding wire use adequately Yes / No

C. FORMWORK :

8. Whether cleaning of formwork is done properly? Yes / No
9. Whether oiling of form work is done adequately? Yes / No
10. Whether erection of formwork is as per requirement? Yes / No
11. Whether geometry of formwork is checked? Yes / No
12. Whether adequacy of supporting system is checked? Yes / No
13. Whether formwork joints are properly sealed? Yes / No

D. CONCRETING:

14. 1Whether all ingredients of concrete are tested? :

Cement	Coarse aggregate	Sand	Water	PVC waterstop
Yes / No	Yes / No	Yes / No	Yes / No	Yes / No

15. Whether the placement units are adequate? : Yes / No
16. Whether the vibrators are adequate? : Yes / No
17. Slump value: (a) Mix design ..... mm
    (b) Observed ..... mm
18. Quantity of concrete placed ..... m^3

19. (a) No of cube set required as per frequency laid down in tender / IS :

(b) No of cube set casted:

20. Overall appearance of concrete placed? Good / Satisfactory / Needs repair
21. Whether honeycombing and other defects observed? Yes / No

(If yes, mention in sr.no.25)

E. JOINTS:

22. Whether joints are as per requirement? Yes / No
23. Whether waterstops are placed properly? Yes / No

F. CURING :

24. Whether curing arrangements are adequate? Yes / No

G. 25. Instruction of Inspecting officer, if any?

Signature of contractor Signature of A.E. / A.A.E. (Construction) Signature of D.E.E.

Signature of D.E.E. / A.E. / A.A.E. (Q.C. Sub Dn.) Signature of Inspecting Officer

Name of Division:

Name of Sub Division:

O.K.CARD FOR C.C.LINING

Name of Work:

Date: Chainage from.....to.....

A. SUB-GRADE:

1. Whether CNS layer permitted? Yes / No
2. If yes, mention thickness ..... cm
3. Whether CNS material tested? Yes / No
4. Whether Profile after CNS layer OR proud removal is within the tol. limit? Yes / No
5. In case of proud removal, over excavation, if any, may be specifically indicated Yes / No
6. Results of test, % of compaction & % of moisture content (Except canal in cutting).....% of MDD, .% of moisture content.....
7. Whether mapping of rock is done? Yes / No
8. Whether necessary approval of sub grade is given? Yes / No
9. Date of approval of sub grade, if applicable .....

B. FOR C.C.LINING :

10. Whether all ingredients of lining tested ?

Cement Coarse Aggregate Sand Water AEA PVC Strip Curing comp. etc
Yes / No Yes / No Yes / No Yes / No Yes / No Yes / No Yes / No

11. Date of casting of sleeper
12. Size of sleeper .....cm X .....cm
13. Whether primer is applied on the top of sleepers? Yes / No
14. Whether sub grade has been properly watered & compacted as per design Yes / No
15. Date of starting C.C.lining
16. Workability of concrete (Slump value) (a) Mix Design..... mm
    (b) Placement site ..... mm
17. Whether concreting is done in alternating panels or bays? Yes / No
18. Whether lining key is constructed alsongwith lining? Yes / No
19. Whether proper cutting of joints has been done? Yes / No
20. Quantity of concrete placed ..... m^3
21. (a) No of cube set required as per frequency laid down in tender / IS :
    (b) No of cube set casted:
    (One set means 6 cubes; 3 for 7 days & 3 for 28 days)

C. For R.C.C. LINING :

22. Dia. & Spacing of bars
23. Whether spacing is properly maintained? Yes / No
24. Whether proper cover is maintained? Yes / No
25. Whether cover blocks / chairs (3M0L) are used for maintaining proper cover? Yes / No

D. AFTER LINING:

26. Overall appearance of lining Good / Satisfactory / Needs repair
27. Are curing arrangement adequate and satisfactory? Yes / No
28. Whether curing compound is applied properly? Yes / No
29. Whether honey combing and other defects observed? Yes / No
30 Whether joint filling is done properly? Yes / No
30. Instruction of Inspection officer, if any ?

Signature of contractor Signature of A.E. / A.A.E.(Construction) Signature of D.E.E.

Signature of D.E.E. / A. E. / A.A.E.(Q.C. Sub-Dn.) Signature of Inspecting Officer

Name of Dn. :

Name of sub-Division :

O.K. CARD FOR SUB GRADE OF BRICK LINING

Name of Work:
Date: Chainage from.....to.....

(A) SUB-GRADE

1 Whether proud has been removed just before placing the leveling course 10 mm thick in C.M. 1:6 (or as specified) Yes/No

2 Whether Template at an interval of 3m to 5m are prepared showing the layers of cement mortar and final profile of cross-section with brick lining? Yes/No

3. Whether the levels after proud removal are within the tolerance limit? Yes/No

4. In case of over excavation, whether earth filling is carried out Watered and Compacted? Yes/No

5. Whether Sub-Grade has been properly watered upto the required depth? Yes/No

6. Whether necessary tests for approval of sub-grade are taken? Yes/No
Results of tests
% age of compaction -
% age of FMC -

7. Whether sub grade is okay from geometrical angle and necessary templates are provided?

8. Remarks

Signature of contractor Signature of A.E. / A.A.E.(Construction) Signature of D.E.E.

Signature of D.E.E. / A. E. / A.A.E.(Q.C. Sub-Dn.) Signature of Inspecting Officer

Name of Division :

Name of sub-Division :

O.K. CARD FOR BRICK LINING

Name of Work:

Date: Chainage from.....to.....

(A) SUB GRADE AND CONSTRUCTION MATERIAL.

1. Whether subgrade is approved? Yes/No
2. Whether sub grade is okay from Geometrical angle and necessary Templates are provided? Yes/No
3. Date and time of approval of sub-grade
4. Whether Bricks to be used are tested and test results are available? Yes/No
5. Whether proper arrangement has been made for soaking of bricks before use? Yes/No
6. Whether over burnt/under brick/pilla bricks/Rejected bricks stacked separately? Yes/No
7. Whether sand to be used is of the approved quality and free from deleterious materials, well screened and of requisite F.M? Yes/No
8. Whether cement to be used is fresh, not older than 90 days? Yes/No
   Brand of cement, Grade, and Batch No.
9. Whether cement Account Book and consumption register maintained upto date and kept available on site? Yes/No
10. Whether Mixer Machine & Weigh batcher have been tested? Corrected batch weight is provided considering the free moisture in sand? Yes/No
11. Board indicating proportion of cement mortar is displayed. Yes/No
12. Whether proper handling arrangement for mortar is done and impervious platform is provided for mortar? Whether mortar tank is being used. Yes/No
13. Total time taken for the use of particular batch of cement mortar (not more than 30 minutes.)
14. Whether the W/C ratio for the required consistency is maintained properly. Yes/No
15. Proper arrangement for measurement of water is provided? Yes/No

(B) MORTAR LAYERS

16. Whether wooden L patties for uniformity in thickness of mortar are used in plaster layer? Yes/No
17. Whether strings and threads are kept on site to be used extensively for ensuring thickness and geometry of plaster? Whether wooden templates are used for curved portion? Yes/No
18. Date and time of starting leveling course i.e. 1st layer of 10mm thick or as specified in cm 1:6 or as specified
19. Whether adequate arrangement for curing is done? (e.g. covered with wet gunny bags etc.) Yes/No
20. Whether 1st layer is moistened, cleaned and scrubbed with broom before the 2nd layer of plaster? Yes/No
21. Date and Time of starting the 2nd layer i.e. impervious layer of specified thickness in C.M. 1:3 proportion/or as specified.
22. Whether the 2nd plaster layer is scrubbed as per requirement with wire brush? Yes/No
23. Whether the 2nd plaster layer is cured? Yes/No
24. Are curing arrangements adequate ? Yes/No

(C) BRICK LINING

25. Date and time of starting the brick lining
26. Whether the bricks are soaked sufficiently Yes/No
27. Whether proper care for putting the bed plaster and filling of frog/joints with mortar taken? Squeezing out of Yes/No

	mortar between the joint spaces checked?	
28.	Whether the masonry is broomed with wire brushes at the end of day ?	Yes/No
29.	Whether the joints have been checked with joint tester and log book is maintained for joint testing ?	Yes/No
30.	Whether adequate curing arrangement for curing in bed like water ponds and slopes to be covered with mats soaked in water, or hose pipe for sprinkling of water on slopes or perforated pipes on top of lining or pucca gutter on top of lining is provided? Specify curing register maintained or not	Yes/No

Signature of contractor Signature of A.E. / A.A.E.(Construction) Signature of D.E.E.

Signature of D.E.E. / A. E. / A.A.E.(Q.C. Sub-Dn.) Signature of Inspecting Officer

Name of Division :

Name of Sub-Division :

O.K.CARD FOR REINFORCEMENT

Name of work :

Date :

Location :

Details of component :

1	Whether reinforcement for RCC work confirm to relevant IS specification?	Yes / No
2	Whether reinforcement has been tested for its quality?	Yes / No
3	Whether reinforcement is cleaned from dust, paint, grease, mill scale or loose or thick rust at the time of placing?	Yes / No
4	Whether placing of reinforcement is as per design and drawing?	Yes / No
5	Whether checking of reinforcement for its size & spacing is done?	Yes / No
6	Whether checking of reinforcement is done for adequacy of cover?	Yes / No
7	Whether supporting system of reinforcement is checked?	Yes / No

Signature of contractor Signature of A.E. / A.A.E. (Construction) Signature of D.E.E.

Signature of D.E.E. / A. E. / A.A.E.(Q.C. Sub-Dn.) Signature of Inspecting Officer

Name of Division:

Name of Sub-Division:

O.K.CARD FOR BRICK WORK

Name of work:

Date:

Location:

1. Whether bricks to be used are tested and test results are available? Yes / No
2. Whether proper arrangement has been made for soaking of bricks before use? Yes / No
3. Whether over burnt / under sized / rejected brick stacked separately? Yes / No
4. Whether sand to be used is of the approved quality and free from deleterious materials, well screened and of requisite F.M.? Yes / No
5. Whether cement to be used is fresh, not older than 90 days? Yes / No
6. Whether cement account book and consumption register maintained up to date & kept available on site? Yes / No
7. Whether mixer machine of weigh batcher have been tested? Yes / No
8. Whether display of proportion of mortar is kept? Yes / No
9. Whether approval of desired bond for laying of bricks is taken? Yes / No
10. Whether number of laborers, mason is adequate? Yes / No
11. Whether proper arrangement for water has been made? Yes / No

Signature of contractor Signature of A.E. / A.A.E.(Construction) Signature of D.E.E.

Signature of D.E.E. / A. E. / A.A.E.(Q.C. Sub-Dn.) Signature of Inspecting Officer

Name of Division:

Name of Sub-Division:

O.K.CARD FOR PLASTER WORK

Name of work

Date Proportion of mix:

Location:

1. Whether surface to be plastered is cleaned of all dust, loose mortar dropping, traces of algae, efflorescence and other foreign matter by water or brush Yes / No
2. Whether scaffolding has been examined before use? Yes / No
3. Whether raking of joints where necessary is don Yes / No
4. Whether surface has been damped evenly? Yes / No
5. Whether planning of external plaster, internal plaster & ceiling plaster has been carried out? Yes / No
6. Whether number of laborers, masons are adequate? Yes / No
7. Whether necessary tests for cement and sand have been made? Yes / No
8. Whether approval of mix of plaster is taken? Yes / No
9. Whether proper arrangement for water has been made? Yes / No

Signature of contractor Signature of A.E. / A.A.E.(Construction) Signature of D.E.E.

Signature of D.E.E. / A. E. / A.A.E.(Q.C. Sub-Dn.) Signature of Inspecting Officer

List of Indian Standards

Sr.No.	Standard No.	TITLE
1.00	CEMENT :	
1.1	IS : 269:1989 (Reaffirmed 2008)	Specification for 33 grade ordinary Portland cement
1.2	IS : 455:1989 (Reaffirmed 2009)	Portland blast furnace slag cement.
1.3	IS : 1489 (Part-I) :1991 (Reaffirmed 2009).	Specification for Portland Pozzolona Cement Fly ash based
1.4	IS : 3466:1988 (Reaffirmed 2008)	Specification for masonry cement
1.5	IS : 3535:1986 (Reaffirmed 2008)	Methods of Sampling hydraulic cement
1.6	IS : 4031(part-I)-1996 (Reaffirmed 2009)	Methods of physical tests for hydraulic cement - Determination of fineness by dry sieving.
1.6.2	(Part-2) : 1999 (Reaffirmed 2008)	--do – Determination of fineness by specific surface by Blaine air permeability
1.6.3	(Part-3) : 1988 (Reaffirmed 2009)	-- do --Determination of soundness
1.6.4	(Part-4) : 1988 (Reaffirmed 2009)	-- do -- Determination of consistency of sand and cement paste
1.6.5	(Part-5) : 1988 (Reaffirmed 2009)	-do-Determination of initial and final setting time
1.6.6	(Part-6) : 1988 (Reaffirmed 2009)	-- do --Determination of comp. strength of hydraulic cement other than masonry cement
1.6.7	(Part-7) : 1988 (Reaffirmed 2009)	-- do -- Determination of Comp. strength of masonry cement
1.6.8	(Part-8) : 1988 (Reaffirmed 2009)	-- do -- Determination of transverse and Comp. stren. of plastic mortar using prism
1.6.9	(Part-9) : 1988 (Reaffirmed 2009)	-- do -- Determination of heat of hydration.
1.6.10	(Part-10) : 1988 (Reaffirmed 2009)	-- do -- Determination of drying shrinkage
1.6.11	(Part-11) : 1988 (Reaffirmed 2009)	-- do -- Determination of density
1.6.12	(Part-12) : 1988 (Reaffirmed 2009)	-- do -- Determination of air content of hydraulic cement mortar.
1.6.13	IS:4031 (Part-13):1988 (Reaffirmed 2009)	-do-Determination of measurement of water retentivity of masonry cement.
1.6.14	4031 (Part-14) : 1989 (Reaffirmed 2005)	-do- Determination of False test.
1.6.15	IS:4031 (Part-15):1991 (Reaffirmed 2005)	-d0- Determination of fineness by wet sieving.
1.7	IS:4032:1985 (Reaffirmed 2009)	Methods of chemical analysis for hydraulic cement
1.8	IS:4905:1968 (Reaffirmed 2006)	Methods for random sampling
1.9	IS:6909:1990 (Reaffirmed 2005)	Specification for super sulphated cement
1.10	IS:8041:1990 (Reaffirmed 2009)	Rapid hardening cement.
1.11	IS:8042:1989 (Reaffirmed 2009)	White Portland cement.
1.12	IS:8112:1989 (Reaffirmed 2009)	43 Grade Ordinary Portland Cement Specification

Sr.No.	Standard No.	TITLE
1.13	IS:12269 – 1987 (Reaffirmed 2008)	Specification for 53 grade ordinary Portland cement.
1.14	IS:12330-1988 (Reaffirmed 2009)	Specification for sulphate resisting Portland cement
2.00	**POZZOLANA :**	
2.1	IS : 1344 : 1981 (Reaffirmed 2008)	Specification for calcined clay pozzolana
2.2	IS : 1727 : 1967 (Reaffirmed 2008).	Method of test for Pozzolanic materials
2.3	IS : 3812 : (Part-I) 2003 (Reaffirmed 2007)	Pulverised fuel ash specification for use as pozzolana in cement, cement mortar and concrete
2.4	IS : 3812 : (Part-II) 2003 (Reaffirmed 2007)	Pulverised fuel ash specification for use as admixture in cement mortar and concrete
2.5	IS:6491:1972 (Reaffirmed 2005)	Method of Sampling of Fly ash
2.6	IS : 10153 :1982 (Reaffirmed 2003)	Guidelines for utilization and disposal for Fly ash.
3.00	**BUILDING LIME :**	
3.1	IS:712:1984 (Reaffirmed 2009)	Specification for building limes
3.2	IS:1128:1974 (Reaffirmed-2008.)	Specification for limestone.
3.3	IS : 1624 : 1986 (Reaffirmed 2009)	Method of field testing of building lime
3.4	IS : 3115 :1992 (Reaffirmed 2009)	Lime based blocks
3.5	IS : 6508 : 1988 (Reaffirmed 2003)	Glossary of terms relating to building lime
3.6	IS : 6932 : 1973 (Reaffirmed 2009)	Methods of test for building limes.
3.6.1	IS : 6932(Part – I):1973 (Reaffirmed 2009)	Determination of insoluble Residue, loss on ignition, insoluble matter, silicon dioxide, ferric and aluminium oxide calcium oxide and magnesium oxide
3.6.2	IS : 6932(Part – 2):1973 (Reaffirmed 2009)	Part 2 - Determination of Carbon dioxide content
3.6.3	IS : 6932(Part-3) : 1973 (Reaffirmed 2009)	Part 3 - Determination of Residue on Slaking of quick lime.
3.6.4	IS : 6932(Part-4) : 1973 (Reaffirmed 2009)	Part 4 - Determination of fineness of Hydraulic lime.
3.6.5	IS : 6932(Part-5):1973 (Reaffirmed 2009)	Part 5 - Determination of unhydrated oxide.
3.6.6	IS:6932(Part-6):1973 (Reaffirmed 2009)	Part 6 - Determination of volume-yield of quick lime
3.6.7	IS:6932(Part-7):1973 (Reaffirmed 2009)	Part 7 - Determination of compressive and transverse strength.
3.6.8	IS:6932(Part-8):1973. (Reaffirmed 2009)	Part 8 - Determination of workability
3.6.9	IS:6932(Part-9):1973 (Reaffirmed 2009)	Part 9 - Determination of soundness.
3.6.10	IS:6932 (Part-10):1973:. (Reaffirmed 2009)	Part 10 - Determination of poping and pitting of hydrated lime.
3.6.11	IS:6932 (Part-11):1983:. (Reaffirmed 2009)	Part 11 - Determination of setting time of hydrated lime.

Sr.No.	Standard No.	TITLE
4.00	STRUCTURAL STEEL:	
4.1	IS:432(Part-I):1982 (Reaffirmed 2009)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement Part-I Mild steel and Medium tensile steel bars
4.2	IS:432(Part-II):1982 (Reaffirmed 2009)	Specification for mild steel and Medium tensile steel bars and hard drawn steel wire for concrete reinforcement Part-2 hard drawn steel wire
4.3	IS:1566:1982 (Reaffirmed 2009)	Hard drawn steel wire fabric for concrete reinforcement
4.4	IS:1599:1985 (Reaffirmed 2006)	Method for bend test
4.5	IS:1608:2005 (Reaffirmed 2008)	Metallic materials - Tensile testing at ambient temperature
4.6	IS:1785(Part-I):1983 (Reaffirmed 2008)	Specification for plain hard drawn steel wire for pre-stressed conc. to part-I cold drawn stress relieved wire
4.7	IS:1785(Part-II):1983 (Reaffirmed 2008)	Specification for plain hard drawn steel wire for pre stressed concrete Part-2 a cold drawn wire
4.8	IS:1786:2008	Specification for high strength deformed steel bars and wires for concrete reinforcement
4.9	IS:1977:1966 **(INACTIVE)**	Low tensile structural steel
4.10	IS:2062:2006	Hot rolled low, medium and high tensile structural steel
4.11	IS:2090:1983 (Reaffirmed 2004)	High tensile steel bars for concrete reinforcement
4.12	IS:8500:1991 **(INACTIVE)**	Structural steel - Micro alloyed (Medium and High strength qualities)
4.13	IS:6003-1983 (Reaffirmed 2003)	Indented wire for prestressed concrete
4.14	IS:6006-1983 (Reaffirmed 2008)	Specification for uncoated stress relived strand for pre stressed concrete
4.15	IS:13620-1993 (Reaffirmed 2008)	Fusion bonded epoxy coated reinforcing bars
4.16	IS:1716-1985 (Reaffirmed 2006)	Reverse bend
5.0	STONE :	
5.1.1	IS:1121(Part-I):1974 (Reaffirmed 2008)	Method of test for determination of strength properties of natured building stones. Part I - Compressive strength
5.1.2	IS:1121(Part-2):1974 (Reaffirmed 2008)	-do- Part II -Transverse strength.
5.1.3	IS:1121(Part-3):1974 (Reaffirmed 2008)	-do- Part III - Tensile strength
5.1.4	IS:1121(Part-4):1974 (Reaffirmed 2008)	-do- Part IV - Shear strength
5.2	IS:1122:1974 (Reaffirmed 2008)	Method of test for determination of true specific gravity of natural building stones
5.3	IS:1123:1975 (Reaffirmed 2008)	Method of Identification of natural building stone
5.4	IS:1124:1974 (Reaffirmed 2008)	Method of test for determination of water absorption apparent sp. gr. and porosity of natural building stone
5.5	IS:1125:1974 (Reaffirmed 2008)	Method of test for determination of weathering of natural building stone
5.6	IS:1126:1974 (Reaffirmed 2008)	Method of test for determination of durability of natural building stone

Sr.No.	Standard No.	TITLE
5.7	IS 8605-1977 (Reaffirmed 2003)	Construction of Masonary in Dams
5.8	IS 1597 (Part I) : 1992	Construction of Stone Masonary
5.9	IS 1597 (Part II): 1992	Ashlar Masonary
5.10	IS Code 1905 – 1987 (Reaffirmed 2007)	Structural use of Unreinforced masonary
5.11	IS 8237-1985	Protection of slope for Reservoir Embankment
5.12	IS 8826-1978	Guideline for Design of large earth and rockfill dams
5.13	IS 9429 – 1999	Drainage system for Earth and Rockfill Dams – code of Practice
6.00	**AGGREGATE :**	
6.1	IS:383:1970 (Reaffirmed 2007)	Specification for coarse and fine aggregate from natural source for concrete.
6.2	IS:1542:1992 (Reaffirmed 2009)	Sand for plasters
6.3	IS:2116:1980 (Reaffirmed 2007)	Sand for masonry mortars
6.4.1	IS:2386(Part-I):1963. (Reaffirmed 2007)	Method of test for aggregate for concrete, Part I - Particle size and Shape,
6.4.2	IS:2386 (Part-2):1963. Reaffirmed 2007)	-- do – Part II - Estimation of deleterious material and organic impurities.
6.4.3	IS:2386(Part-3):1963. (Reaffirmed 2007)	-do- Part III - Specific gravity density voids, absorption and bulking.
6.4.4	IS:2386(Part-4):1963.	-- do -- Part IV - Mechanical properties.
6.4.5	IS:2386(Part-5):1963. (Reaffirmed 2007)	-- do -- Part V - Soundness,
6.4.6	IS:2386(Part-6):1963. (Reaffirmed 2007)	-- do -- Part VI - Measuring mortar making properties of fine aggregate.
6.4.7	IS:2386(Part-7):1963 (Reaffirmed 2007)	-- do -- Part VII - Alkali aggregate reactivity,
6.5	IS:2430:1986 (Reaffirmed 2009)	Method for sampling of aggregate for concrete
6.6	IS:5640:1970 (Reaffirmed 2008)	Method of test for determining aggregate impact value of soft coarse aggregates.
6.7	IS :238 : Part 8 (Reaffirmed 2007)	Petrograpic Examination.
7.00	**BRICKS :**	
7.1	IS:654:1992 (Reaffirmed2007)	Specification for clay roofing tiles Mangalore pattern
7.2	IS:1077:1992 (Reaffirmed 2007)	Specification for common burnt clay building bricks
7.3	IS:2117:1991 (Reaffirmed 2007)	Guide for manufacture of hand made common burnt clay building bricks
7.4	IS:2248:1992 (Reaffirmed 2007)	Glossary of terms relating to clay products for building
7.5	IS:3495:1992(Part-I to 4) -1992 (Reaffirmed 2007)	Method of test for burnt clay building bricks Part-1 to 4(Comp Str., Water Abs.,Efflorescence, Warpage)
7.6	IS:4860:1968 (Reaffirmed 2006)	Specification for acid resistant bricks
7.7	IS:5454:1978 (Reaffirmed 2006)	Method of sampling of clay building bricks
7.8	IS:6165:1992 (Reaffirmed 2007)	Dimensions for special shapes of clay bricks

Sr.No.	Standard No.	TITLE
8.00	TILES :	
8.1	IS:1237:1980 (Reaffirmed 2006)	Specification for cement concrete flooring tiles
8.2	IS:1464:1992 (Reaffirmed 2007)	Clay ridge and ceiling tiles
8.3 8.4	IS:2690 (Part- I) :1993 (Reaffirmed 2007) (Part-2) : 1992 (Reaffirmed 2007)	Burnt clay flat terracing tiles – Machine made --do—Hand made
8.5	IS:4457:2007	Specification for ceramic unglazed vitreous acid resisting tile
9.00	LDPE FILM:	
9.1	IS:2508:1984 (Reaffirmed 2008)	Low density polyethylene films
10.00	TIMBER :	
10.1	IS:1708 (Part-1 to 18):1986 (Reaffirmed 2005)	Method of testing of small clear specimen of timber
10.2	IS: 2202 (Part-1):1991. (Reaffirmed 2009)	Wooden flush door shutters (Solid core type) – Plywood face panel
10.3	IS:2408;1963 (Reaffirmed 2005)	Methods of static tests of timber in structural sizes.
10.4	IS:4970:1973 (Reaffirmed 2005)	Key for identification of commercial timber
11.00	ADMIXTURE :	
11.1	IS:2645:2003 (Reaffirmed2007)	Integral water proofing compound. cement for mortar and concrete
11.2	IS:9103:1999 (Reaffirmed2008)	Specification for Concrete Admixture
12.00	CONCRETE:	
12.1	IS:456:2000 (Reaffirmed 2005)	Code of practice for plain and reinforced concrete
12.2	IS:457:1957 (Reaffirmed 2005). **(INACTIVE)**	code of practice for general construction of plain and reinforced concrete for dams and other massive structure.
12.3	IS:458:2003 (Reaffirmed 2008)	Precast Concrete pipes (with and without reinforcement)
12.4	IS:516:1959 (Reaffirmed 2008)	Method test for strength of concrete.
12.5	IS:1199:1959 (Reaffirmed 2008)	Methods of sampling and analysis of concrete.
12.6	IS:1791:1985 (Reaffirmed 2009)	General requirements for batch type concrete mixtures
12.7	IS:1834:1984 (Reaffirmed 2005)	Hot applied sealing compounds for joints in concrete
12.8 12.9	1838(Part1)1983 (Reaffirmed 2005) (Part 2) 1984 (Reaffirmed 2005)	Preformed fillers for expansion joints in concrete pavement and structures (non extruding & resilient type-Part I - Bitumen impregnated fiber. Part II - CNSL Aldehyde resin and coconut pith.
12.10.1	IS:2185(Part-1):2005	Specification for concrete, masonry units part-1. Hollow and solid concrete blocks
12.10.2	IS:2185(Part-2):1983 (Reaffirmed 2005)	Specification for concrete masonry units, Part-2 Hollow and solid light weight concrete blocks
12.10.3	IS:2185(Part-3):1984	Specification for concrete masonry units part-3,

Sr.No.	Standard No.	TITLE
	(Reaffirmed 2005)	Autoclave cellular aerated concrete blocks
12.11	IS:3085:1965 (Reaffirmed 2007)	Methods of tests for permeability of cement mortar and concrete.
12.12	IS:3597:1998 (Reaffirmed 2008)	Method of testing for concrete pipes.
12.13	IS:10646 : 1991 (Reaffirmed 2009)	Canal lining – cement concrete tiles
12.14	IS:3873;1993 (Reaffirmed 2004)	Code of practice for laying cement concrete / stone slab lining on canals
12.15	IS:4926;2003 (Reaffirmed 2007)	Ready mixed concrete
12.16	IS:4969:1968 **(INACTIVE)**	Superseded by 10646
12.17	IS:9012;1978. (Reaffirmed 2007)	Recommended practice for shotcreting
12.18	IS:10262:2009	Recommended guideline for concrete mix design.
13.00	**MASONARY MORTAR :**	
13.1	IS:2116:1980 (Reaffirmed 2007)	Specification of sand for masonry mortars
13.2	IS:2250:1981 (Reaffirmed 2005)	Code of practice for preparation and use of masonry mortars.
14.0	**SEALING COMPOUND**	
14.1	IS:5256:1992 (Reaffirmed 2008)	Code Of Practice For Sealing Expansion Joints In Concrete Lining Of Canals
14.2	IS:13143:1991(Reaffirmed 2009)	Joints In Concrete Lining Of Canals-Sealing Compound – Specifications
15.0	**WATER (For construction)**	
15.1	IS:456:2000 (Reaffirmed 2005)	Code of practice for plain and reinforced concrete.
15.2	IS:3025 **(INACTIVE)**	Methods of sampling and test (physical and chemical) for water and waste water.
15.3	IS : 3025 (Part 17) : 1984 (Reaffirmed 2006)	--do—Non filterable
15.4	IS : 3025 (Part 18) : 1984 (Reaffirmed 2006)	--do—Volatile and fixed residue
15.5	IS : 3025 (Part 24) : 1986 (Reaffirmed 2009)	--do—Sulphate
15.6	IS : 3025 (Part 32) : 1988 (Reaffirmed 2009)	--do—Chloride
16.00	**CURING COMPOUND**	
16.1	ASTM-C-309-2007	Specification for liquid membrane forming compounds for curing concrete.
16.2	C-156-2007	Test method for water retention by concrete curing material
16.3	D- 869 –1985	Method for evaluating degree of settling of paint.
16.4	D-1309-1988	Test method for settling properties of traffic paint.
16.5	D-1644-1988	Test methods for non volatile content of varnish
16.6	E-1347-1990	Test method for color and color difference measurements by Tristimulus (filter) Colorimetry.
17.00	**PVC Water Stops**	
17.1	IS:8543(Part-4)-1984 (Reaffirmed 2003) **(INACTIVE)**	Method of testing plastics. Part – 4 Short term mechanical properties : Sect.1 : Determination of tensile properties

Sr.No.	Standard No.	TITLE
17.2	IS:12200-2001 (Reaffirmed 2008)	Code of practice for provision of water stops at transverse contraction joints in masonry & concrete dams.

Important Note :

- Reaffirmation years are latest and taken from the IS web site.
- IS which are inactivated by ISI are shown as “Inactive” after IS number in Column 2 of above list.
- Inactivated ISs are not removed from the list of IS above , rather shown (Inactive) , so as they may not be put in use accidently.
- Inactivated ISIs are superseded by various ISIs test wise , details of which are covered in the web pages of BIS site. Latest updating details may be had from web site.
- Advanced search facility at web site is versatile with effective user-friendly search tools.

ABREVIATION

ABBREVIATIONS		FULL FORM
AE	:	Assistant Engineer
AAE	:	Additional Assistant Engineer
DEE	:	Deputy Executive Engineer
QC	:	Quality Control
FM	:	Fineness Modulus
PVC	:	Poly Vinayl Chloride
N	:	Newton
I S	:	Indian Standard
ACI	:	American Cement Institute
RCC	:	Reinforced Cement Concrete
ASTM	:	American Society of Testing Material
CTM	:	Compression Testing Machine
CNS	:	Compressed Natural Soil
MDD	:	Maximum Dry Density
CM	:	Cement Mortar
FMC	:	Field Moisture Content