(For office use only)

# GUIDE LINES

# FOR

# QUALITY CONTROL AND QUALITY ASSURANCE

## Vol. 1

**Gujarat Engineering Research Institute**
**Narmada, Water Resources & Water Supply Department**
**Vadodara**
**2002**

# CONTENTS


**FOREWORD**

**PREFACE**

**I EARTH WORK**

General E – 1

Borrow area investigation

Embankment construction E – 2

Sampling Methods (Table 1) E – 5

Simple field tests for identification of soils (Table 2) E – 6

Testing of soils (Table 3) E – 7

List of Indian Standards – Soils (Table 4) E – 11

Quantity of soil sample required for tests (Table 5) E – 14

On earth work (Table 6) E – 15

O. K. Card for Earth work (Table 7) E – 16

List of records to be kept (Table 8) E – 17

Statement showing daily tests carried out for the earth work (Table 9) E – 18

**II MATERIALS**

Concrete M – 1

Recommended values of slump for different conditions M – 8

Field tests for common materials M – 9

Materials – Name of tests, frequencies, equipment, acceptance criteria and purpose of testing M – 11

O. K. Card for concreting at structures M – 39

O. K. Card for concrete (at batch mix plant) M – 40

O. K. Card for C C lining M – 41

O. K. Card for brick lining M – 43

List of Indian Standards M – 46

## FOREWORD

It has been said that “entirely safe and substantial design may be entirely ruined by careless and shoddy execution. Careful attention to the details of the construction is, therefore, as important as the preliminary investigation and design. The consequences of being ignorant of, or ignoring the quality aspects may result into catastrophic failure of the structure."

All civil engineering projects deal with a large variety of natural construction materials as well as factory made products. Before execution of any structure, properties of these materials are required to be determined. Selection of suitable materials and their use in building a safe and economical structure forms a very crucial process in the whole construction project. This process is known as quality control and quality assurance.

Determination of properties of natural as well as factory made products is done by laboratories as per standard test procedures laid down by the Bureau of Indian Standards. These standards also lay down frequency of testing and acceptance criteria. These criteria should be followed to meet with the assumptions made in design of the structure. This is the only way of providing guarantee for structural safety.

Quality control is obtained through testing of raw materials and end products. Inspection of workmanship and insistence on good performance by those who executes a project is also a part of quality control. But they collect samples subject them to various tests and receive results from laboratories. These results have to be interpreted and then they have to assure the owner of the structure (Government) and the people, about quality of the work as it is envisaged in the design. These guideline when used in consultation with various standards enlisted will provide with an effective tool to achieve quality control and provide quality assurance to the owner.

These guidelines should not be used as specifications of any particular work. A specific work has its own set of specifications. It should naturally and legally override the contents of this manual. As such, the constructing agency has to follow this guideline in conjunction with the standard specifications and use appropriate the information for filling up gaps in the requirements of inspection and quality control.

The manual is divided into two sections viz, (i) Earth work (i.e. Soils) & (ii) Materials

Part 1, “EARTHWORK” include construction sequence of planning, borrow area investigations, and embankment construction. The specific points to be inspected and looked into are mentioned. Frequency of testing, acceptance criteria, purpose of testing are also included to help constructing agency. "DO" and "DON'Ts" are also highlighted.

Part 2, "CONSTRUCTION MATERIALS" include guidelines for concrete making, brick and stone masonry, plaster, analysis of cement and concrete, quality control of brick/tiles for canal lining etc. It also includes field tests for common construction materials. Particulars of test with frequency, equipment, acceptance criteria, purpose of testing for different construction materials are given. List of related Indian Standards is also given.

These guidelines serve as a ready reckoner for the construction engineers. They are made considering work tender provisions in general, however if there are any aspects beyond such provisions leading to other implications, the guidelines may be adopted only after obtaining requisite approval from competent authority.

M. S. Patel
Secretary (WR)
Narmada, Water Resources & Water Supply Department

# 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. They therefore call for similar construction techniques and hence similar quality control. General activities carried out for earthwork are given below

- Stripping of borrow area and excavations to the required limiting depth or as per site conditions
- Laboratory testing of various materials available from excavation and / or borrow areas
- Suitability decision for specific application
- Determination of Natural Moisture Content (NMC) of borrow area material
- Determination of Proctor density values i.e. Maximum Dry Density (MDD), Optimum Moisture Content (OMC) and degree of compaction
- 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 material by stripping to 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)
- 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 programme of borrow area investigation should be decided in consultation with Central Design Organisations & GERI.

Borrow area investigations consist of four 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. Atterbergs limits (LL, PL, PI)
5. Density moisture relationship (light), Std. 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, swelling index etc. is 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 Govt. circular M/S 1077-V-255-K2-1977 should be reffered.

3.1 Homogeneous embankment: This consists of practically uniform quality of material. There is no designed plan of material distribution in the embankment in to zones.

3.2 Zoned embankment

From borrow area excavation

(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 and carefully
- 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 monds 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 or as specified
- The laying is to be done for full width of the embankment and is built up regularly in layers in accordance with the designed embankment section, with provision for dressing the shoulders or proudes
- All clods are broken at the borrow pits. Any 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 are not being taken up for lying at a stretch, the end edges of embankment are provided with steps is 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 in to be compacted is predetermined in the laboratory
- Compaction is achieved by using appropriate rollers 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 on embankment under construction.

(vi) Field control

It is necessary to establish a field laboratory to carry out requisite tests in field while compaction operations are in progress. The lab provides a continuous approximate 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 deficiencies are made good by suitably adjusting the moisture content and number of passes of the roller. The density determination tests are done

(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 quality control. For rapid check, O. K. Card given in Table 7 is used. The list of records to be maintained and format of maintaining daily test report are given 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 of 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 followed 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 are fulfilled as minimum of 70% RD or as specified

Following filter between casing and core material or between two consecutive casing materials if more than one casing material is used.

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

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

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

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 geofabrics can also be adopted. The minimum required properties including filter criteria of fabric are included in the chapter of “Sub Materials”.

## TABLE -1
## SAMPLING METHODS

**Disturbed samples**

(a) From trial pits : From individual stratum by cutting a notche in the side

(b) From bore holes

- (i) Auger samples
- (ii) Samples from S. P. T. spoons
- (iii) Wash samples in case of granular soils or bailer samples

**Undisturbed samples**

(a) From trial pits

- i) Chunk sample
- ii) Core cutter samples

(b) From bore holes

- i) Shelby tubes
- ii) Piston tube samples

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

(i) Dry density in place at accessible locations by sand or water replacement method

(ii) Standard penetration tests in bore holes

(iii) Dynamic cone penetration tests in bore holes

(iv) Pressuremeter tests in bore hole

(v) Plate load test

## 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, and no reaction, if the water condition does not appear to change. Observe and report type of reaction as descriptive information.<br>• Fine clean sands react quickly & distinctly<br>• Very fine-grained cohesionless soils like silt and rock flour react somewhat slowly than fine sands<br>• Plastic clays do not react to this<br>• 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 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; medium, if considerable finger pressure is required and high, if it cannot be powdered at all. Observe and record the dry strength as descriptive information. |
| (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<br>IS : 2720-4-1985 (2001 RA) | As per relevant specification provisions or 1 per 1000$m^3$ | Coarse sieve (80mm, 63, 37.5, 25.0, 20.0, 10.0, 6.3, 4.75 mm)<br>Fine sieves (2mm, 600 micron, 425, 212, 75 micron), balances oven, stirrer, hydrometer with jars | As specified | For classification of soil and there by getting indication of properties |
| 2 | Plasticity index<br>IS : 2720-V-1985 (2001 RA) | As per relevant specification provisions or 1 per 1000$m^3$ | Uppal's cone penetrometer, sieves, oven, ground glass, spatula balance, containers | As specified<br>Workable range for Hearting<br>LL 35 to 50<br>PL 20 to 30<br>PI 15 to 30 | Indicates properties of soils. Test not possible for nonplastic soils which are used for casing |
| 3 | Standard compaction<br>IS : 2720-VII-1980 (1997 RA) | As per relevant specification provisions or 1 per 1000$m^3$ | Standard compaction mould 1000$m^3$ with base, collar and rammer of 2.6 kg, soil extractor, balance 20 kg, oven, spatula | As per design | For determining the maximum density which can be attained on field at optimum moisture content, with standard energy in put |
| 3 A | Heavy compaction<br>IS : 2720 (Part-VIII)-1983 (2001 RA) | 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 | Some as above but with heavy energy |
| 4 | Relative density<br>IS : 2720-XIV-1983 (2001 RA) | As per relevant specification provisions or 1 per 1000$m^3$ | Relative density apparatus, vibrator, balance 50 kg, oven surcharge plates, Moulds with base plate | As specified | Similar as above but for coarse grained soils |
| 5 | Permeability<br>IS : 2720-XVII-1986 (1997 RA) | As per relevant specification provisions or 1 per 1000$m^3$ or as required | Permeability apparatus, soil extractor, oven. | Workable range for hearting, less than $10^{-6}$ cm/sec. Casing more than $10^{-4}$ cm/sec or as specified | 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)<br>IS : 2720-XIII-1986 (1997 RA) | As per relevant specification provisions or 1 per 1000$m^3$ or as required | Direct shear apparatus, soil extractor, balance 5 kg. Shear moulds with grid plates, porous stone, loading pad, dial gauge, proving ring | As per design | To determine shear strength of soil in foundation or in an embankment<br>To find out safe bearing capacity of soil |
| 6 A | For soil containing gravel more than 4.75 mm size<br>IS :2720-XXXIX-1979 (1997 RA) | As per relevant specification provision or 1 per 1000$m^3$ or as required | Direct shear apparatus - large size with all accessories, balance 20kg, dial gauge, proving ring etc. | As per design | To determine shear strength of soil in foundation or in an embankment |
| 7 | Triaxial compression (uu)<br>IS : 2720 (Part XI)-1993<br>(1997 RA) | As per relevant provision | Triaxial shear apparatus, loading frame, Bishop por pressure apparatus, Constant pressure system, Soil extractor, Balance 5 kg, Membrane stretcher, Split mould, Proving ring, Dial gauge etc. | As specified | To determine shear strength of soils<br>in unconsolidated undrained condition |
| 7 A | Triaxial compression (cu)<br>IS : 2720 (Part - XII)- 1981<br>(1997 RA) | As per relevant provision or 1/1000$m^3$ | Triaxial shear apparatus, loading frame, Bishop por pressure apparatus, Constant pressure system, Soil extractor, Balance 5 kg, Membrane stretcher, Split mould, Proving ring, Dial gauge etc. | As specified | To determine shear strength of soils in foundation or in embankment<br>in consolidated undrained condition<br>To find out S. B. C. of soil |
| 8 | Consolidation<br>IS : 2720-XV-1986 (1997 RA) | 1 set of 3 samples per season per zone at end of season<br>or as specified | Consolidation test apparatus. Stop watch, oven, extractor. balance | As per design | To determine settlement rate and magnitude & to assess whether soil is normally consolidated or preconsolidated<br>To determine allowable bearing pressure |
| 9 | Unconfined compression<br>IS : 2720-X-1973 (2001 RA) | As per relevant specification provisions or 1 per 1000$m^3$ | Compression device sample extractor, Dial gauge, Oven, Balance | As specified | To determine unconfined compressive strength of soil and shear parameter |

| | | | | | |
|---|---|---|---|---|---|
| 10 | Free swell index<br>IS : 2720-(Part XL-1977<br>(1997 RA) | As per relevant specification provision | Sieve graduated glass cylinder 100cc capacity | As specified | To determine swelling index of soil |
| 11 | Swelling pressure of soils<br>IS : 2720-(Part XLI-1977<br>(1997 RA) | As per relevant specification provision | Swell pressure apparatus or consolidometer, dial gauge, proving ring etc. | As specified | To determine swelling pressure of soil |
| 12 | Pin hole test<br>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 | Field density and moisture<br>IS : 2720-XXVII-1977 (1997 RA)<br>2720-XXIX-1975 (2001 RA)<br>2720-XXXIII-1971 (2001 RA) | 1 per 300$m^3$, minimum one in each zone per layer or as specified,<br>1 per 5000$m^3$ for Rock fill | Core cutter, sand replacement kit and water replacement kit | 95 percent of MDD or 70 percent of RD Moisture OMC ±2 percent or as specified<br>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<br>IS :2720 (Part-2)-1973<br>(2001 RA) | 1 per 300 $m^3$ or as specified | Balance & oven or rapid moisture meter | Depending upon OMC results | To determine degree of saturation, consistency rate of natural strata or a compacted soil |

| | | | | | |
|---|---|---|---|---|---|
| 3 | Field permeability IS : 5529-I-1985 (1995 RA) | 1/3 m depth or as required | Field permeability apparatus like water storage drum, shovels, augers etc. | 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. |
| 4 | Standard Penetration Test (SPT) IS : 2131-1981 (1997 RA) | 1.5m to 2.0m depth in bore hole or as specified | Drilling equipment, Split spoon sampler, Drive weight assembly, screw jack etc. | 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-1997 (1992 RA) IS : 4968-Part-II-1976 (1997 RA) | Continuous in bore hole up to specified depth | Standard cone, Driving head, Hoisting equipment hammer etc. | As specified | To determine penetration resistance of sub soil (Strata wise) |
| 6 | Load Test on soil IS : 1988-1982 (1888 RA) | As specified | Plate 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 | Pressuremeter Test I S : 1892-1979 (1997-RA) | As specified | Pressuremeter assembly | As specified | To determine SBC and deformation characteristic of soil |

**TABLE - 4**
**LIST OF INDIAN STANDARDS – SOILS**
**UPDATED FROM CATALOGUE OF BUREAU OF INDIAN STANDARDS 1997**

| Sr. No. | IS: Code No. | Title |
|---|---|---|
| 1 | 1498-1970 | Classification and Identification of soils for general engineering purposes (First revision), (amendments 2) Reaffirmed-1997 |
| 2 | 1888-1982 | Method of load test on soils (Second revision), Reaffirmed 1997 |
| 3 | 1892-1979 | Code of practice for sub surface investigations for foundations (First revision), Reaffirmed 1997 |
| 4 | 1904-1986 | Code of practice for design and construction of foundation in soils, General requirements (Third revision), Reaffirmed 2000 |
| 5 | 2131-1981 | Method of standard penetration test for soils (First revision), Reaffirmed 1997 |
| 6 | 2132-1986 | Code of practice for thin walled tube sampling of soils (Second revision), Reaffirmed 1997 |
| 7 | 2720 (Part 1) – 1983 | Methods of test for soils: Part 1. Preparation of dry soil samples for various tests. (Second revision), Reaffirmed 1995 |
| 8 | 2720 (Part 2) – 1973 | Methods of test for soils: Part 2. Determination of water content. (Second revision), Reaffirmed 2001 |
| 9 | 2720 (Part 3/Sec.1) – 1980 | Methods of test for soils: Part 3. Determination of specific gravity, Sec. I, Fine grained soils (First revision), Reaffirmed 1997 |
| 10 | 2720 (Part 3/Sec.2) – 1980 | Methods of test for soils: Part 3. Determination of specific gravity Sec.2, Fine medium and coarse grained soils (First revision), Reaffirmed 1997 |
| 11 | 2720 (Part 4) – 1985 | Methods of test for soils: Part 4. Grain size analysis (Second revision), Reaffirmed 2001 |
| 12 | 2720 (Part 5) – 1985 | Methods of test for soils: Part 5. Determination of liquid and plastic limit (Second revision), Reaffirmed 2001 |
| 13 | 2720 (Part 6) – 1972 | Methods of test for soils: Part 6. Determination of shrinkage factors (First revision), Reaffirmed 2001 |
| 14 | 2720 (Part 7) – 1980 | Methods of test for soils: Part 7. Determination of water content-dry density relation using light compaction (Second revision), Reaffirmed 1997 |
| 15 | 2720 (Part 8) – 1983 | Methods of test for soils: Part 8. Determination of water content-dry density relation using heavy compaction (Second revision), Reaffirmed 2001 |
| 16 | 2720 (Part 9) – 1992 | Methods of test for soils: Part 9. Determination of dry density – moisture content relation by constant weight of soil method (First revision), Reaffirmed 1997 |
| 17 | 2720 (Part 10) – 1991 | Methods of test for soils: Part 10. Determination of unconfined compressive strength (Second revision), Reaffirmed 2001 |
| 18 | 2720 (Part 11) – 1993 | 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 (First revision), Reaffirmed 1997 |

| Sr. No. | IS: Code No. | | Title |
|---|---|---|---|
| 19 | 2720 (Part 12) – 1981 | | 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 (First revision), Reaffirmed 1997 |
| 20 | 2720 (Part 13) – 1986 | | Methods of test for soils: Part 13. Direct shear test (Second revision), Reaffirmed 1997 |
| 21 | 2720 (Part 14) – 1983 | | Methods of test for soils: Part 14. Determination of density index (relative density) of cohesionless soils (First revision), Reaffirmed 2001 |
| 22 | 2720 (Part 15) – 1986 | | Methods of test for soils: Part 15. Determination of consolidation properties (First revision), Reaffirmed 1997 |
| 23 | 2720 (Part 16) – 1987 | | Methods of test for soils: Part 16. Laboratory determination of CBR (Second revision), Reaffirmed 1997 |
| 24 | 2720 (Part 17) – 1986 | | Methods of test for soils: Part 17. Laboratory determination of permeability (First revision), Reaffirmed 1997 |
| 25 | 2720 (Part 18) – 1992 | | Methods of test for soils: Part 18. Determination of field moisture equivalent (First revision), Reaffirmed 1997 |
| 26 | 2720 (Part 19) – 1992 | | Methods of test for soils: Part 19. Determination of centrifuge moisture equivalent (First revision), Reaffirmed 1997 |
| 27 | 2720 (Part 21) – 1977 | | Methods of test for soils: Part 21. Determination of total soluble solids (First revision), Reaffirmed 2001 |
| 28 | 2720 (Part 22) – 1972 | | Methods of test for soils: Part 22. Determination of organic matter (First revision), Reaffirmed 2001 |
| 29 | 2720 (Part 23) – 1976 | | Methods of test for soils: Part 23. Determination of calcium carbonate (First revision), Reaffirmed 2001 |
| 30 | 2720 (Part 27) – 1977 | | Methods of test for soils: Part 27. Determination of total soluble sulphates (First revision), Reaffirmed 2001 |
| 30 A | 2720 (Part 29) - 1975 | | Methods of test for soils: Part-29: determination of dry density of soils in-place by the core-cutter method. (First Revision) Second Reprint Feb. '87. Reaffirmed 2001 |
| 31 | 2720 (Part 31) – 1990 | | Methods of test for soils: Part 31. Field determination of California Bearing Ratio (First revision), Reaffirmed 2001 |
| 32 | 2720 (Part 36) – 1987 | | Methods of test for soils: Part 36. Laboratory determination of permeability of granular soils (Constant head) (First revision), Reaffirmed 1997 |
| 33 | 2720 (Part 39/Sec.1) – 1977 | | Methods of test for soils: Part 39. Direct shear test for soils containing gravel, Sec.1, Laboratory test (Amendment 1) Reaffirmed 1997 |
| 34 | 2720 (Part 39/Sec.2) – 1979 | | Methods of test for soils: Part 39. Direct shear test for soils containing gravel. Sec.2 In-situ shear test Reaffirmed 1997 |
| 35 | 2720 (Part 40) – 1977 | | Methods of test for soils: Part 40. Determination of free swell index of soils. Reaffirmed 1997 |
| 36 | 2720 (Part 41) – 1977 | | Methods of test for soils: Part 41. Determination of swelling pressure of soils, Reaffirmed 1997 |

| Sr. No. | IS: Code No. | Title |
|---|---|---|
| 37 | 2809-1972 | Glossary of terms and symbols relating to soil engineering (First revision), Reaffirmed 2001 |
| 38 | 2911 (Part 4) – 1985 | Code of practice for design and construction of pile foundations. Part 4, Load test on piles (First revision)(Amendment-1), Reaffirmed 2000 |
| 38 A | 4332 (Part I) - 1967 | Methods of test for stabilised soils Part-1 -Method of sampling & preparation of stabilised soils for testing (Second Reprint March '84) Reaffirmed 1995 |
| 39 | 4434-1978 | Code of practice for In-situ vane shear test for soils (First revision), Reaffirmed 1997 |
| 40 | 4701-1982 | Code of practice for earthwork on canals. Reaffirmed 1999 |
| 41 | 4968 (Part 1) – 1976 | Method for subsurface sounding for soils (Part 1) Dynamic method using 50 mm cone without bentonite slurry (First revision) (Amendment 1), Reaffirmed 1997 |
| 42 | 4968 (Part 2) – 1976 | Method for subsurface sounding for soils (Part 2) Dynamic method using cone and bentonite slurry (First revision) (Amendment 1), Reaffirmed 1997 |
| 43 | 4968 (Part 3) – 1976 | Method for subsurface sounding for soils (Part 3) Static cone penetration test (First revision), Reaffirmed 1997 |
| 44 | 5529 (Part 1) – 1985 | Code of practice for In-situ permeability test (Part 1) Test in overburden (First revision), Reaffirmed 1995 |
| 45 | 6403-1981 | Code of practice for determination of bearing capacity of shallow foundations (First revision) (Amendment 1), Reaffirmed 2000 |
| 46 | 6955-1973 | Code of practice for subsurface exploration for earth and rock fill dams, Reaffirmed 1995 |
| 47 | 8009 (Part 1) – 1976 | Code of practice for calculation of settlement of foundations (Part 1) Shallow foundations subjected to symmetrical static vertical loads (Amendment 1), Reaffirmed 1998 |
| 48 | 8009 (Part 2) – 1980 | Code of practice for calculation of settlement of foundations (Part 2) Deep foundations subjected to symmetrical static vertical loading (Amendment 1), Reaffirmed 2000 |
| 48 A | 8237 - 1985 | Code of practice for protection of slope for reservoir embankment (1st Revision), Reaffirmed 1997 |
| 49 | 8763-1978 | Guide for undisturbed sampling of sand and sandy soils, Reaffirmed 1997 |
| 50 | 9214-1979 | Method for determination of modulus of sub grade reaction (K-value) of soils in the field (Amendment 1), Reaffirmed 1997 |
| 51 | 9451-1985 | Guidelines for lining of canals in expansive soils (First revision), Reaffirmed 1999 |
| 52 | 9640-1980 | Split spoon sampler (amendment 2), Reaffirmed 1997 |
| 53 | 10042-1981 | Code of practice for site investigations for foundation in gravel boulder deposits, Reaffirmed 1997 |

**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 | 20 kg | 20 kg | 20 kg | - | - |
| | (b) Heavy compaction | 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** | | **Authorised sign.** |
| | (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---------- | |
| | (6) | 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 of field staff

**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 $m^3/m^2$ | 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 | Remarks |
|---|---|---|---|---|---|---|---|
| 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 Deputy Ex. Engineer

Signature of field officer

## 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 were noticed after removal of cover in concrete of slab and beam. Surfacial defects like honeycombing shrinkage cracking, pourlines, 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, developed 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
- Levelling of mixer on levelled 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
- Measurement of boxes
- Adjustable arrangement in boxes
- Weight of boxes

2.3 Materials :

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

- 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 and the other details of various tests on sand are given in Table No. 11.

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

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

- Type and source
- Gradation
- Adequate stock

2.3.4 Water: The requirements and the other details of various tests on water are given in Table No. 21.

- 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 clerance 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 of 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 reigster, 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 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 labourers to prevent disposition of reinforcement

**3.0 Batching:**

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

3.1 Materials are maintained homogeneous and non-seggregated 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, resonable 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 untill 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 seggregation 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. Unrerstrained dropping, chuting and horizontal flow of concrete should not be permited.

5.4 Minimum handling and persistant precautions should be observed to prevent segregation and to see that concrete ramains 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 & revibrate 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, rodding 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 seggregation 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 Vibrations 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 of vibrators should receive special consideration to avoid surface blemishes.

7.8 The use of suitable mechanical vibrators complying with IS:2505-1968, IS:2506-1968, IS:4656-1968 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 levelled appearance of concrete at exposed surface, embedment of surface aggregate, explusion of entrapped air, formation of cement skin and appearance of cement slurry at surface.

**8.0 Finishing:**

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.

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

8.2 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.

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

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

8.5 Sprinkiling of dry cement or a dry mortar should not be permitted.

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

8.7 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 stopping on surface will leave an imprint of about 5mm.

8.8 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.

8.9 If surface is trowelled too soon, a layer of laitence is found, if too late, the partly harded concrete is too hard to be trowelled effectively.

8.10 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:**

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.

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

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

9.3 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

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

d. Removal of props under slabs:
1. Spanning upto 4.5 m 7 days
2. Spanning over 4.5 m 14 days

e. Removal of props under beams and arches:
1. Spanning upto 6 m
14 days
2. Spanning over 6 m
21 days

f. Modify stripping time suitably for other cements

9.4 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 to assure satisfactory hydration of cementitious 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, hession 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 $40^{o}$c 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 subgrade 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.

**12. 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.

**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 masonry 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) Spalls 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 beded in the mortar
8) Iron templetes 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.

**c) Plaster work:**

- The details are covered in IS: 1661 – 1972
- 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 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 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 guidelines on control charts for concrete are given in ACI 214-1977. Recommended Practice for evaluation of strength test results of concrete, Indian Standards IS:397 (Part 1 to 3) also 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 chart. 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.

**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, PVC strips & 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
- Cores to be taken to check positioning of PVC insertion in C.C. lining
- To undertake screening of green concrete for examining consistency of concrete (occasionally)
- Proper curing arrangements

**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.

**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) |
|---|---|---|
| Blinding concrete; Shallow sections; Pavements using pavers | Very low | See 7.1.1 of IS: 456-2000 |
| 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 ; Slipform work; Pumped concrete | Medium | 50 - 100 |
| Trench fill; In-situ piling | High | 100 - 150 |
| Tremie concrete | Very high | See 7.1. 2 of IS: 456-2000 |

**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 are not required to be used ( see also 13.3 of IS: 456-2000).**

**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<br>State of aggregation : Lumpy, powdery, soft and hard<br>Class C lime : White or pure white colour-hard<br>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.<br>Effervescence indicates unburnt lime<br>Residue after 24 hours indicates inert material, comparison with original volume of lime indicates its proportion<br>Classification :<br>Class A : Good thick gel at top and inert material at bottom<br>Class B : Medium thick gel which does not flow when turned<br>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<br>Classification :<br>Class A : No expansion<br>Class B : Little expansion and numerous cracks on surface<br>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<br>Classification :<br>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 behaviour 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<br>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.<br>Coarseness of sand – gradation can be judged by comparison with bottle specimens, missing fractions indicate gap gradation<br>Physically deleterious material like coal, clay-balls, mica, lime kankar 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. Shales absorb water and give earthy smell, phyllite and mica 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.<br>Shales absorbs water and give earthy smell |
| 9 | Steel bar | Bending | Free from rust, grease, oil; mild steel can be bent to 'U' shape with mendrel of 2 d with indicating cracks. Check diameter and weight per unit length |
| 10 | Tiles | (a) Visual<br>(b) Strength | Check dimensions, colour, expose tiles to sunlight for few days and observe for loss of colour<br>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 are given in the 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 flattended. 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 to 15) - 1988 to 1996, 4032-1986**

**Sample : 15 kg.**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1. | Consistency IS:4031-(Part-4)-1988 | Upto 50 T. - 1<br>50-100 T. -2<br>100 - 200 T -3<br>each sample or as required | 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 | | | | |
| | (a) Initial setting time | Each sample or as required | Vicat apparatus with needle 1 mm sq. (c-Type) | Not less than 30 minutes | Placement compaction is to be completed within initial time. |
| | (b) Final setting time | | Vicat apparatus with annular attachment (F-type) | Not more than 600 minutes | Final setting time limit indicates hardening and gain in strength. |
| 3. | Fineness | | | | |
| | (a) By sieving IS:4031-(Part-I)-1988 | Each Sample or as required | 90 micron IS sieve and balance | Residue less then 10 percent | More volume retained on sieve indicates cement having undergone moisture attack or inadequate grinding. |
| | Specific surface by Blain air permeability IS:4031-(Part-2)-1988 | Each sample or as required | Blain air permeability apparatus with accessories | Not less than 2250 $cm^2/g$ for OPC (33,43,& 53 grade) & SRC. Not less than 3000 $cm^2/g$ for PPC | Less volume indicates cement having undergone moisture attack or inadequate grinding. |
| 4. | Soundness IS:4031-(Part-4)-1988 | | | | |
| | (a) Le Chatelier's method | Each sample or as required | Le Chatelier's apparatus with accessories | Expansion not more than 10 mm | More expansion indicates likely excessive and harmful chemical reactions. |
| | (b) Autoclave method | 1 in 10 samples | Autoclave, length comparator, 25 x 25 x 250 mm mould and other accessories. | Expansion not more than 0.80 percent. | -do- |
| 5. | Compressive strength IS:4031-(Part-6)-1988 | 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:4032-1986 | 1 in 10 sample | Muffle furnace, oven, platinum crucible, chemical balance etc. | As per Table-4 | |

**TABLE - 4**
**VARIOUS TYPES OF CEMENT**

| Sr. No. | Particulars of Tests | Acceptance criteria | | | | | Purpose of testing |
|---|---|---|---|---|---|---|---|
| | | 33-G | 43-G | 53-G | PPC | SRC | |
| 1. | Compressive strength (Min.) $N/mm^2$ | | | | | | |
| | 3 days | 16 | 23 | 27 | 16 | 10 | |
| | 7 days | 22 | 33 | 37 | 22 | 16 | |
| | 28 days | 33 | 43 | 53 | 33 | 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 | – | Between 0.66 and 1.02 | |
| | (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 2.5 & 3 when $C_3A$% is 5 or less & > 5 respectively | 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 | It indicates the freshness of cement |
| | (g) $C_3$ A% | -- | -- | -- | -- | Maximum 5.0 | |
| | (h) $C_4AF+2C_3$ A% | -- | -- | -- | -- | Maximum 25.00 | |

**TABLE - 5**
**Pozzolana (Calcined clay, flyash)**
**IS:1344 – 1981, IS:3812-1981, IS:1727-1967**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Sample – 15 kg. Purpose of testing |
|---|---|---|---|---|---|
| 1. | Lime reactivity IS:1727-1967 | 1/100 t | Flow table, mixing apparatus, humidity cabinet, 5 t loading frame | Not less than 40 kg/$cm^2$ | Less lime reactivity indicates inadequate content of reactive silica to combine with free lime |
| 2. | Fineness by specific surface area by Blain's method IS:1727-1967 | 1/5 Samples | Blains permeability apparatus | For calcined clay not less than 2250 $cm^2$/g<br>For flyash not less than 3200 $cm^2$/g | Higher the fineness greater the strength, lesser bleeding and better workability |
| 3. | Compressive strength IS:1727-1967 | 1/100 t | Vibrating machine 40 t compression testing machine | At 28 days minimum 80 percent of the strength of plain cement mortar cube.<br>At 90 days it shall not be less than that of 28 days strength | Higher strength is acceptable |
| 4. | Chemical analysis IS:1727-1967 | 1/5 Sample | Muffle furnace, Platinum crucible, Balance | Constituent — Unburnt Clay (Soil) — Flyash<br>$SiO_2 + Al_2O_3 + Fe_2O_3$ — Not less than 70 % — Not less than 70%<br>$SiO_2$ (min) — 40 % — 35 %<br>$Na_2O+K_2O$(max.) — 3 % — 1.5 %<br>Water Soluble alkali (max.) — 1 % — -<br>Loss on ignition(max.) — 10 % — 12 %<br>CaO (max.) — 10 % — -<br>MgO (max.) — 3 % — 5 %<br>$So_3$ (max.) — 3 % — 2.75 % | Silica constituent has to be the major one. MgO causes expansion and disintegration |

**TABLE - 6**
**Building lime**
**IS: 712-1989, 6932 (Part 1 to 11) – 1973**

**Sample – 10 kg packed tin**

| Sr. No. | Particular of Test | Frequency | Equipment | Acceptance Criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1. | Workability IS:6932-(Part-8)-1973 | 1/100 T 2/300 T Each sample | Flow table with moulds, Oven, Triple beam balance | Bumps more than 12 for flow from 11 to 19 cm for C and D types | Determines water requirement for subsequent tests |
| 2. | Fineness IS:6932-(Part-4)-1973 | -do- | Sieves 2.36 mm, 850 micron, 300 micron | No residue on 2.36 mm. 5 percent residue on 850 micron for A and B Class<br>No residue on 850 micron for C class. 10 percent residue on 300 micron for A and B class<br>5 percent residue on 300 micron for C class | Higher residue indicates inadequate calcination and slaking |
| 3 | Setting time IS:6932-(Part-2)-1984 | -d0- | Vicat needle apparatus | For Class A<br>Initial – Not less than 2 hours<br>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 | -do- | Pug mill, 5 cm cube three moulds, 5 ton loading frame | A class 17.5, 28 kg/cm$^2$at 14 and 28 days<br>B Class 12.5, 17.5 kg/cm$^2$ at 14 and 28 days | Hardening is measured in terms of compressive strength which further indicates class of lime |
| 5 | Transverse strength IS:6932-(Part-7)-1973 | 1 in 5 samples | 2.5X2.5X10 cm moulds Transverse strength tool, 5 ton loading frame | A class 10.5 kg/cm$^2$ at 28 days<br>B Class 7.0 kg/cm$^2$ at 28 days | Hardening is measured in terms of transverse strength and indicates type of lime |
| 6 | Soundness IS:6932-(Part-9)-1973 | 1 in 5 samples | Le Chaterlier apparatus | Maximum expansion 10 mm | Excessive expansion indicates higher content of MgO |

| Sr. No. | Particular of Test | Frequency | Equipment | Acceptance Criteria | Purpose of testing |
|---|---|---|---|---|---|
| 7 | Chemical analysis IS:6932-(Part-1)-1973 | Each sample | Muffle furnace, Oven, Platinum crucible, Chemical balance, Water bath | Analysis percentage<br>Class A B C D E<br>CaO+MgO min 60 70 85 85 25<br>MgO…max 5 5 5 5 5<br>$SiO_2+R_2O_2$ min 25 15 - -<br>Cementation Value to min. 0.6 0.3 - -<br>to 0.6 | Excessive content of MgO causes expansion. Relative percentage of CaO and $SiO_2$ indicate class of lime |
| 8 | Lime content for lime stabilised soil/moorum IS:1514-1959 or 712-1984 | a) Before 1 consignment mixing subject to minimum of 1 test per 5 T lime<br>b) After 1/250 $m^2$ mixing | | As per IRC-51-1992<br>Lime as CaO not less than 50 percent and 60 percent for lime soil and lime flyash stabilisation respectively<br>No result shall be less than 75 percent of specified lime content<br>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, IS: 1785 (Part 1 & 2) – 1983, IS: 1608-1993, IS: 1599-1985, IS: 1786-1985, IS:1716-1985**

**Sample: 60 cm long**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1. | Tensile, Yield, Elongation IS: 1608-1995 | 1 per 40 t | Universal testing machine, Vernier calliper, centre-Punch, Hammer | As per table 8 | The measure of its strength and elasticity |
| 2. | Bend IS: 1599-1985 | 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: 1786-1985 | 1 per 20 t | For Fe 415 & 500 Universal testing machine, mendreals 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 | Sample: Number of coils 3 in 25 – 4 - 65<br>5 - 180<br>7 - 300<br>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 $5.6\sqrt{S_o}$ |
|---|---|---|---|---|---|
| 1. | Mild steel and medium Tensile steel Bars and Hard-Drawn Steel wire for concrete reinforcement<br>IS: 432(Part I) – 1982 (Third Revision) Mild steel and medium tensile steel bars | Mild steel gr.I | | | |
| | | 0 – 20 | 410 | 250 | 23 |
| | | 20 – 50 | 410 | 240 | 23 |
| | | Mild steel gr.II | | | |
| | | 0 – 20 | 370 | 225 | 23 |
| | | 20 – 50 | 370 | 215 | 23 |
| | | Medium Ten. Steel | | | |
| | | 0 – 16 | 540 | 350 | 23 |
| | | 16 – 32 | 540 | 340 | 20 |
| | | 32 – 50 | 510 | 330 | 20 |
| | IS:432(Part-2)-1982, Hard drawn steel wire | All sizes | 570 | 480 | 7.5 |
| 2. | High strength deformed steel bars and wires for concrete Reinforcement<br>IS: 1786-1985<br>(Third Revision) | All sizes | Grade Fe 415<br>485 | 415 * | 14.5 |
| | | | Grade Fe 500<br>545 | 500 * | 12.0 |
| | | | Grade Fe 550<br>585 | 550 * | 8.0 |
| 3. | Plain Hard-Drawn steel wire for prestressed concrete<br>IS: 1785 (Part I) – 1983<br>Cold Drawn Stress – Relieved Wire<br>(Second Revision) | 2.50 | 2010 | 85 Percent of the minimum specified tensile strength | 2.5 |
| | | 3.00 | 1865 | | 2.5 |
| | | 4.00 | 1715 | | 3.0 |
| | | 5.00 | 1570 | | 4.0 |
| | | 7.00 | 1470 | | 4.0 |
| | | 8.00 | 1375 | | 4.0 |
| 4. | Plain Hard-Drawn Steel Wire for prestressed concrete<br>IS: 1785 (Part II) – 1983<br>As – Drawn Wire (Ist Revision) | 3.00 | 1765 | 75 Percent of the minimum specified tensile strength | |
| | | 4.00 | 1715 | | |
| | | 5.00 | 1570 | | |

Gauge length 200 mm

| 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 $5.6\sqrt{S_o}$ |
|---|---|---|---|---|---|---|---|
| | | | | < 20mm | 20-40 mm | >40mm | |
| 5. | Steel for General structural purposes – specification | Gr. A Fe 410 WA (All sizes) | 410 | 250 | 240 | 230 | 23 |
| | IS: 2062 – 1992 (Fourth Revision) | Gr. B. Fe 410 WB (All sizesa) | 410 | 250 | 240 | 230 | 23 |
| | Steel plates, strips, sections, flats, Bars etc. | Gr. C. Fe 410 WC (All sizes) | 410 | 250 | 240 | 230 | 23 |

*Indicates proof stress at 0.2 percent of the original gauge length

**TABLE - 9**
**Building Stone**
**IS:1597(Part 1 & 2)-1992 IS:1121 (Part - 1 to 4)-1974, IS:1122-1974, IS:1124-1974, IS:1125-1974**

**Sample-2 Rubble 25x25x25 cm**

| Sr. No. | Particular s of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1 | Specific gravity (apparent) &water absorption IS:1124-1974 | 1/week | Mortar & pestle,150micron sieve,sp.gr.bottle, balance, cylinder | Absorption:Not more than 5% for rubble masonary. Not more than 2.5% for sand stone flooring | Lesser the water absorption higher the durability,lesser the weathering. For dams higher porosity causes more leakage |
| 2 | Specific gravity (true) IS:1122-1974 | 1/week | Mortar & pestle,150micron sieve,sp.gr.bottle, balance, cylinder | As per relevant specifications | Higher the specific gravity more is the durability & economy |
| 3 | Porosity IS:1124-1974 | 1/week | Mortar & pestle,150micron sieve,sp.gr.bottle, balance, cylinder | As per relevant specifications | |
| 4 | Compressive strength IS:1121(Part –I)-1974 | Building /bridges 2 sets of tests per working season | Rock cutting machine 200 t compression testing machine | Workable range: Granite-1000kg/$cm^2$ Basalt-400kg/$cm^2$ Sand stone-300kg/$cm^2$ | Indicates load carrying capacity & integrity |
| 5 | Transverse strength for flooring IS:1121(Part-2)1974 IS:3622-1977- | 1/800Nos. | 5t loading frame, transverse block | Sand stone-70 kg/$cm^2$ | Ensures least breakage |
| 6 | Shear strength IS:1121(Part-4)1974 | 2 sets of tests per working season | Shear tool | Workable range: Granite-140-500kg/$cm^2$ Basalt-200-600kg/$cm^2$ Sandstone-80-400kg/$cm^2$ | Ensures integrity against vertical sustained load. |
| 7 | Weathering IS:1125-1976 | 2 sets of tests per working season | Balance,gypsum powder | As per design | Measure of durability & strength |

**TABLE - 10**
**Coarse.Aggregate (Metal,gravel etc.)**
**IS: 2386-1963 (Part 1 to 8), IS: 383-1970**

**Sample : 100 kg.**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1. | Gradation : IS:2386(Part-1)-1963 | 1/150 $m^3$ for concrete or as per specification | Set of coarse sieves 80mm to 4.75mm, balance | As per relevant specifications' provision | Gradation governs the bulk density and void content. |
| 2. | Sp.gravity & water absorption IS:2386(Part-3)-1963 | 2/season | Wire basket, two pan balance, oven | As per relevant specifications' provision Sp.gravity generally 2.5 to 3.0 and water absorption 1 to 1.5% | Higher the specific gravity the higher the density and greater the durability. |
| 3 | Flakiness & elongation indices IS:2386-(Part-1)-1963 | As per specification | Balance, 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 | 2/season | Impact testing machine, triple beam balance, sieves | 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 | 2/season | Los angel's abrasion machine, balance, sieves | As per IS:383-1970 Concrete- Wearing surface-30%max. Over laid surface-45%max. | Higher abrasion value indicates more wear &tear &higher cost of repairs & maintenance |
| 6 | Soundness IS:2386(Part-5)1963 | 2/Season | Sieves, oven | As per-IS:383-1970 Concrete- Loss with $Na_2SO4$ -12%max. Loss with MgSo4 -18%max. | Higher loss indicates less ability of the stones to withstand effect of freezing & thawing |
| 7 | Alkali reactivity IS:2386-(Part-7)1963 | 2/Season | Reactivity container,water bath,balance | As per Sc/Rc curve of IS or relavant specifications provisions | Deleterious aggregate cause disintegration of concrete |
| 8 | Petrografic examination IS:2386(Part-8)-1963 | 2/Season | Microscope,hammer, balance | 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), IS:383-1970**

**Sample 20 kg**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1 | Gradation<br>Fineness modulus<br>IS: 2386-(Part-1)1963 | 1/150$m^3$ or as per requirements of the relevant specification | Fine sieve set of 4.75,2.36,1.18mm & 600,300.150,75 micron, balance | As per relevant and specification provision and looking to the purpose of the use<br>For concrete IS:383-1970<br>Masonary mortar IS:2116 –1980<br>Plaster IS:1542-1992 | Poor gradation & lower F.M.give low strength, demand more water for mixing |
| 2 | Specific gravity & water absorption<br>IS: 2386-(Part-3)1963 | 2/Season | Pycnometer, oven, two pan balance | As per relevant specifications & design | Lower specific gravity & higher water absorption decrease durability & density & increase shrinkage |
| 3 | Silt content<br>IS: 2386-(Part-1)1963 | 1/150$m^3$ | 75 micron sieve, balance, oven | Not more than 3% or the relevant specifications' provision | Higher silt content reduces strength, increases water requirement & inhiibits bond |
| 4 | Alkali reactivity<br>IS: 2386-(Part-1)1963 | 2/Season | Reactivity container, water bath, balance | As per Sc/Rc curves of IS or Relevant specifications provisions | Amorphous silica,glass,mica content lead to chemical disintegration |
| 5 | Petrographic examination<br>IS: 2386-(Part –8)1963 | 2/season | Microscope, balance | Relevant specifications' provision or deleterious constituents plus silt content not more than 5% | Deleterious material beyond 5% affects durability |

**TABLE - 12**

Building Bricks

**IS : 1077 - 1992, IS : 3495 (Part 1 to 4) - 1992.**

**Sample : 20 bricks.**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1. | Dimension and tolerance IS:1077-1992 | 50 bricks from 50,000 (20 bricks) | Steel tape | For 19 x 9 x 9 cm (for 20 bricks) Length 3720 to 3880, Width 1760 to 1840, Height 1760 to1840 | Uniform bricks need minimum thickness of joint and hence less mortar. Bond improves. |
| 2. | Water absorption IS : 3495 (Part-2) 1992 | 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 | 5 bricks | Compression 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 | 5 bricks | Glass dish or porcelain or stoneware dish | Classified as Nil - No deposition of salt on Bricks.<br>Slight - Deposit of salt covering 10 % of exposed brick area.<br>Moderate- Thin deposit of salt cover-Ing upto 50 % of the exposed brick area. | Excess efflorescence causes disintegration and defacement. |
| 5. | Chemical analysis of soil for suitability of preparing bricks. IS : 2117 - 1991 | Each soil sample (5 bag) | Chemical balance furnace, water bath. | CaO+MgO Not more than 1% for alluvial and not more than 15 % for other than alluvial.<br>Water soluble Salts maximum 1 % | Initial indication of suitability of soil for bricks. |

**TABLE - 13**
**Acid Resistant Bricks**
**IS: 4860 – 1968**

**Sample – 24 Bricks**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1. | Dimensions and tolerances 230 X 114 X 64mm IS:4860-1968 | 50 Bricks from 1000 & sub sample of 24 | Tape | Permissible tolerances shall be as follows<br>Tolerances<br>Length $\pm$ 3.5 mm<br>Width $\pm$ 2.0 mm<br>Height $\pm$ 1.0 mm | Acceptable bricks mean economy, less joints and more durability |
| 2. | Water absorption IS:4860-1968 | 5 Bricks | Oven, Balance | Class I – Not more than 2 %<br>Class II – Not more than 4 % | Indicates integrity of bricks and masonry or lining |
| 3. | Compressive strength IS:4860-1968 | 5 Bricks | 200 t Compression testing machine | Class I – Not less than 700 $kg/cm^2$<br>Class II – Not less than 500 $kg/cm^2$ | Strength and durability are ensured |
| 4. | Flexural strength IS:4860-1968 | 5 Bricks | 40 t Universal testing machine of loading frame | Class I – Not less than 100 $kg/cm^2$<br>Class II – Not less than 70 $kg/cm^2$ | Strength and durability are ensured |
| 5. | Resistance to acid IS:4860-1968 | 1 Brick | Chemical balance | Class I – Not more than 1.5 %<br>Class II – Not more than 4.0 % | Indicates capacity to withstand corrosive action and hence durability |

**TABLE - 14**
**Cement Concrete Flooring Tiles**
**IS: 1237 - 1980**

**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 30 kg / $cm^2$ | 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.<br>Length mm / Breadth mm / Thickness mm<br>200 / 200 / 20<br>250 / 250 / 22<br>300 / 300 / 25 | |
| 5. | Tolerances | -do- | Steel foot rule | Length or Breadth ± 1 mm<br>Thickness + 5 mm | |

**TABLE - 15**
**Low Density Polythelene Film (LDPE)**
**IS:2505-1989**

**Sample : 10 $m^2$**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1 | Tolerance on thickness | Lot size / No.of samples<br>1 / 1<br>2-15 / 2<br>2-16 / 3<br>41-65 / 5 | Micrometer or thickness gauge meter | Up to & including 40µ - ±25%<br>Above 40µ ± 20% | Uniformity, assurance of performance, economy |
| 2 | Tensile strength | -do- | Tensile testing machine | Tensile strength $MN/m^2$(min)<br>a)length wise 11.77<br>b)cross wise 8.33 | The measure of tensile strength |
| 3 | Elongation | -do- | Tensile testing machine | Elongation %(min)<br>a) length wise 200<br>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 | To examine resistance to impact |

**TABLE - 16**
**Flush Door**
**IS: 2191 (Part – I) – 1983, IS: 2202 (Part – I) – 1991**

**Sample : 2 Nos.**

| Sr. No. | Particulars of Tests | Frequency | | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|---|
| 1. | Dimension and tolerances | Lot<br><br>26-50<br>51-100<br>101-150<br>From above 2 samples to be selected | Sample size<br><br>8<br>13<br>20 | Steel taper, vernier caliper | Height + 3mm<br>Width + 3 mm<br>Thickness $\pm$ 1.2 mm<br>Thickness variation not more than 0.8 mm<br>Permissible limit for defective upto 50-0 number, 300-1, | Trueness of shape and form defined edges ensure tight fitting |
| 2. | End immersion | -Above- | | Curing tank, Steel foot rule | No delemination | To check the quality of glue resin used in the flush door, so as to ensure durability |
| 3. | Adhesion | -Above- | | Water heater, Vernier caliper | No delemination in the plywood 3 pieces out of 4 should not have single delemination 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, IS:516-1959, IS: 1199-1959**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1. | Mixer efficiency IS:4634-1968 | At start of job and occasionally for each batching plant/mixer - Requirement of work | Container, Mixer, weighing balance etc. | 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 | Ensures intimate homogeneous mixing and uniform dispersal of cement paste |
| 2. | Workability IS: 1199-1959 | Daily for each shift at plant and site | Slump cone, Tamping rod, steel tape | It should be as per "Hand book on concrete mixes" based on Indian Standards | Ensures proper placement and minimum voids |
| 3. | Yield & Unit weight IS: 1199 – 1959 | Occasionally or as directed by Engineer in charge | 0.03 $m^3$ container, Weighing balance, Tamping rod | $\pm$ 2% from design or as specified in the specification | Useful for determining and controlling cement level |
| 4. | Air content IS: 1199-1959 | -do- | Air entrainmeter with accessories | $\pm$ 1% from design or as specified in the specification | Higher air content causes reduction in strength |
| 5. | Compressive strength IS: 516-1959 | As per IS and as specified in the relevant specification<br>Quantity of concrete in work $m^3$ — No. of sample:<br>1-5 — 1<br>6-15 — 2<br>16-30 — 3<br>31-50 — 4<br>51 & above — 4 plus one additional sample for each additional 50 $m^3$ or part thereof | 200 t compression testing machine, 15 cm cube mould, Vibrating machine | As per relevant specifications provision<br>Grade designation — Specified characteristic compressive strength at 28 days, $N/mm^2$ ($kg/cm^2$) Approx:<br>M 10 — 10 (100)<br>M 15 — 15 (150)<br>M 20 — 20 (200)<br>M 25 — 25 (250)<br>M 30 — 30 (300)<br>M 35 — 35 (350)<br>M 40 — 40 (400)<br>Upto M80 in increment of 5 — Upto 80 (800) in increment of 5 (50) | To evaluate the quality of concrete, its acceptability. If not acceptable measures to improve are tried. |

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| | Note : (1) At least one sample is taken from each shift<br>(2) Each sample consists of three test specimens for testing at 28 days. Additional cubes are required for various purposes such as to strength of concrete at 7 days or at the time of striking the form work, or to duration of curing, or the size testing error. | | | (A) The concrete shall be deemed to comply with the strength requirements when both the following condition are met :<br>a) The mean strength determined from any group of four consecutive test results compiles with the appropriate limits in col 2 of Table below<br>b) Any individual test result complies with the appropriate limits in col 3 of Table below<br>(B) If the concrete is deemed not to comply persuant to (B), 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<br>Note :<br>1. The total number of test results required to constitute an acceptable record for calculation of standared deviation shall be not less than 30. Attempts should be made to obtain the 30 test results as early as possible, when a mix is used for the first time.<br>2. Concrete of each grade shall be assessed separately | |

| Sr. No. | Particulars of Tests | Frequency | Equipments | 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 $N/mm^2$ | |
| | | | | (1) | (2) | (3) | |
| | | | | M 15 | $\geq f_{ck} + 0.825 \times$ established standard deviation (rounded off to nearest 0.5 $N/mm^2$) or $f_{ck} + 3$ $N/mm^2$ whichever is greater | $\geq f_{ck} - 3$ $N/mm^2$ | |
| | | | | M 20 or above | $\geq f_{ck} + 0.825 \times$ established standard deviation (rounded off to nearest 0.5 $N/mm^2$) or $f_{ck} + 4$ $N/mm^2$ whichever is greater | $\geq f_{ck} - 4$ $N/mm^2$ | |
| | | | | NOTE: In the absence of established value of standard deviation, the values givenin 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. | | | |

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| (B) | Ordinary and controlled concrete for road bridge | 3 cubes/60 $m^3$ each for 7 and 28 days age, Further that every day for first six days and once in three days there after. | 200 tonne compression testing machine | Average compressive strength of each day should not be less than specified strength subject to that 20 percent cubes per day (i.e. 1 per 5 may fall below specified strength upto its 85 percent). | |
| (C) | Concrete pavements roads and runways IRC-SP-11-1981<br>IRC-15-1981 | 3 cubes/beams for each age of 7 and 28 days for every 30$m^3$. | 200 tonne compression testing machine | Lower control limit calculated for a tolerance level of 1 in 15 test results, shall not be lower than the specified minimum strength. The lower control limit is given by the mean-value of the set of tests minus 1.6 times the standard deviation. | |
| 2 | Hardened concrete | | | | |
| | (A) Concrete pavement/Bridge. IRC-Sp.-11-1981 IRC:15-1981;Test if failure in test 1 | 2 cores/30$m^3$ | Core drilling machine | The crushing strength of cores shall not be less than 0.8 times the corresponding crushing strength of cubes | To evaluate the quality of concrete, its acceptability. If not acceptable measures to improve can be tried. |
| | (B) Dams | 3 cores/1500$m^3$ | Do | As in 1(A) + 1(B) | |

Note: For tests 1 and 2, if individual results vary by more than $\pm$ 15 percent from average strength, reject those only (maximum rejection 1 in 3 or 2 in 5 cubes), and rework the average.

**TABLE - 18**
**R.C.C. Precast Concrete Pipes**
**IS:458-1988 & IS:3597-1985**

**Sample-4Nos**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1 | Dimension test IS:458-1988 | 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 | Hydraulic test IS:3597-1985 | 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/$cm^2$ is applied &maintained for the specified time | To know the leakage at certain pressure. To ensure water tightness |
| 3 | Three edge bearing test IS:3597-1985 | 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 subgrade |
| 4 | Absorption test IS:3597-1985 | - | Oven, Balance | a) Absorption in the first 10 minutes shall not exceed 2.5 percent of the dry mass<br>b) Total absorption at the end of 24 hrs. shall not exceed 6.5 percent of the dry mass | 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**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1. | Consistency (Workability) IS:2250-1981 | 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 | 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 | 1 / week | Permeability apparatus | As specified in the relevant specification | Ensures water tightness |
| 4. | Water retentivity IS:2250-1981 | When mortar is to be used with masonry unit which has got high suction characteristics. | Water retentivity 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 | 1/50$m^3$ | 0.03$m^3$ 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, insitu permeability apparatus with pressure gauge and packers. | As per design | Ensures water tightness. |

**33TABLE - 20**
**Sealing Compound**
**IS:13143-1991, 5256-1968**

**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 | It shall not be less than 85$^{o}$ C | For determination of softening point of sealing compound |
| 2. | Penetration at 25$^{o}$C 100 g 5%, 1/10 IS:1203-1978 | | Penetrometer with accessories | Minimum – 15, Maximum – 30 | To determine the grade of sealing compound |
| 3. | Flash Point IS:1209-1978 | | Pensky-Martens closed Tester | Minimum 200$^{o}$C | To determine the flash point & fire point of sealing compound |
| 4. | Pour Point IS:1834-1984 | | | Maximum 170$^{o}$ C | To ensure viscocity & workabiulity |
| 5. | Increase in softening point after heating to 20$^{o}$ C above the maximum pour point for 3 hrs. IS:1205-1978 | | Ring & Ball apparatus, Bath & Stirrer | Maximum 5$^{o}$ C | To determine increase in softening point of sealing compound |
| 6 | Extensibility at 0$^{o}$C IS:1834-1984 | | | Minimum 6 mm | Determination of capacity to extend |
| 7 | Water content IS:1211-1978 | | Dean & Stane Assembly, Heater | Maximum 0.5 percent by weight | To determine water content of sealing compound |

**TABLE - 21**
**Water (For concrete & Mortar)**
**IS : 456 - 2000**
**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 | | | Generally not less than 6 | 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 | | | 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 | | | 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 | | | 3000 mg/l max. | Excess inorganic matter causes efflorescence. |
| | Sulphate (mg/l) IS : 3025 (part-24) -1986 | | | 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 | | | 2000 mg/l max. | |
| | Neutralization of alkalinity IS : 3025 (part-23) - 986 | | | 25 ml with 0.02 N $H_2SO_4$ max. | |
| | Neutralization of acidity IS : 3025 (part-22) - 1986 | | | 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.

**TABLE - 22**
**Curing compound**
**ASTM C-156-1989 C-309-1989, D-1309-1988, D-1644-1988, E-1347-1990**

**Sample: 1 litre**

| Sr. No. | Particulars of Tests | Frequency | Equipments | Acceptance criteria | Purpose of testing |
|---|---|---|---|---|---|
| 1 | Water retention test ASTM C-156-1989 | 1lit.per 1000 lit. or as specified in the relevant specification | Mould, sprayer, balance, humidity chamber etc. | Water loss after 72 hrs.-not more than 0.55 kg/cm$^2$ | To find out the ability to reduce moisture loss during the early hardening period |
| 2 | Reflectance test ASTM E-1347-1990 | -do- | Tristimulus colorimeter | 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-309-1989 | -do- | Mould, sprayer, humidity chamber | a) Dry to touch not more than 4 hrs.<br>b) After 12 hrs. the compound shall not be tracky or track off the specimen | To know the drying time requirement |
| 4 | Long term settling ASTM D 1309-1988 | -do- | | Rating between 4 to 10 | |
| 5 | Non volatile content ASTM D-1644-1988 | -do- | Pipette, Oven, Balance, Desicator | - | To find out non volatile content of curing compound |

**TABLE - 23**
**PVC Water stops**
**IS: 8543-(Part 4)-1984 IS: 12200-1987, 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 | 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 | -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 24.60$kg/cm^2$ | |
| 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- | | $\pm$ 0.10 percent max. | |
| | b) Hardness change | -do- | | $\pm$ 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 | | | $\pm$ 1 percent | |
| 8. | Durometer Hardness | | | $\pm$ 1 percent shore “D” | |

**TABLE - 24**
**Admixture for Concrete**
**IS: 9103-1979**

**Sample : 1 Litre**

| Sr.No. | Particulars of test | | Frequency | Equipment | Acceptance criteria | | | | Purpose of Testing |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Accelerating Admixture | Retarding Admixture | Water reducing Admixture | Air entrain Admixture | |
| 1. | Water content of control sample | | 1/1000 lit. | Oven with Thermometer | - | - | 95 | - | To evaluate % of water |
| 2. | Setting time allowable deviation from control sample in hrs. | | | Vicat Apparatus with initial & final needle | | | | | To know the suitability in concrete/ mortar in setting time |
| | Initial | | | | -3 max.<br>-1 min. | +3 max.<br>+1 min. | ± 1 max. | -<br>- | |
| | Final | | | | -2 max.<br>-1 min. | +3 max. | ± 1 max. | -<br>- | |
| 3. | Compressive Strength Allowable from control mix (%) | Days<br>3<br>7<br>28 | | C.T.M machine | 125 min.<br>100 min.<br>100 min. | 90 min.<br>90 min.<br>90 min. | 110 min.<br>110 min.<br>110 min. | 90 min.<br>90 min.<br>90 min. | To know the suitability in concrete/mortar in strength |
| 4. | Flexural strength Allowable from control mix (%) | Days<br>3<br>7<br>28 | | Flexural Testing machine | 110 min.<br>100 min.<br>90 min. | 90 min.<br>90 min.<br>90 min. | 100 min.<br>100 min.<br>100 min. | 90 min.<br>90 min.<br>90 min. | To know the suitability in concrete/mortar in strength |
| 5. | Length change percent increase from control sample | | | | | | | | To know the shrinkage in mortar / concrete |
| | 28 Days<br>6 Months<br>1 Year | | | Length change comperater | 0.010 max.<br>0.010 max.<br>0.010 max. | 0.010 max.<br>0.010 max.<br>0.010 max. | 0.010 max.<br>0.010 max.<br>0.010 max. | 0.010 max.<br>0.010 max.<br>0.010 max. | |

| Sr.No. | Particulars of test | Frequency | Equipment | Acceptance criteria | | | | Purpose of Testing |
|---|---|---|---|---|---|---|---|---|
| | | | | Accelerating Admixture | Retarding Admixture | Water reducing Admixture | Air entrain Admixture | |
| 6. | Bleeding<br>percent increase over control sample | | Pipette, Temping Bar, Cylinder | 5 max. | 5 max. | 5 max. | 2 max. | To determine relative quantity of mixing water that will bleed from a sample. |

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

Location of plant :

Grade of concrete : M-

Date :

Proportion as per mix design.

Location of placing concrete :

| | | |
|---|---|---|
| 1. | Coarse aggregate : Natural or crushed | ---------- |
| 2. | Whether gradation, Size and quality of coarse aggregates are as per specifications and mix design ? | Yes/No |
| | Give % oversize and under size. | ---------- |
| 3. | Is the coarse aggregate free from excessive silt ? Specify actual % of silt | |
| 4. | F. M. of Sand | ---------- |
| 5. | Is the sand free from excessive silt ? Specify actual % of silt | Yes/No |
| | | ---------- |
| 6. | Type and brand of cement : PPC/OPC | ---------- |
| | A.E.A. | |
| | Water | |
| | | ---------- |
| 7. | a. Start of pour | |
| | b. End of pour | ---------- |
| 8. | a. Total $m^3$. batched | ---------- |
| | b. Total $m^3$. placed | ---------- |
| | c. Total $m^3$. wasted | ---------- |
| 9. | Ambient temperature at Start : …. at Finish :… | ---------- |
| 10. | Mixing time specified | ---------- |
| 11. | W/C ratio | ---------- |
| 12. | Slump specified | ---------- |
| 13. | a. Slump at batchmix plant | |
| | at placement site | ---------- |
| | b. Air content | ---------- |

Sign. of Contractor

Sign. of AE/AAE

Deputy Exe. Engineer

DEE/AE/AAE
Quality Control Sub. Dn.
Name of Divison :

Sign. of Inspecting Officer.

Name of Sub-Division :

**Name of Dn.** :
**Name of Sub Dn.** :

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

Name of Work :
Name of Structure :
Location :

Type of Con. :
Proportion : as per mix desing

Details of component :
Date of Start : Time :
Date of Completion : Time :

Embient Temp. :
Enbient Temp. :

**A. SURFACE PREPARATION :**

| | | |
|---|---|---|
| 1. | Whether the cleaning of foundation is done as specified? | Yes/No |
| 2. | Dewatering arrangement whether adequate? | Yes/No |
| 3. | Whether foundation mapping is done? | Yes/No |
| 4. | Whether the surface to receive the concrete is prepared as specified? | Yes/No |

**B. REINFORCEMENT :**

| | | |
|---|---|---|
| 5. | Whether placing of reinforcement is as per design and drawings? | Yes/No |
| 6. | Whether cleaning and checking of reinforcement is done? | Yes/No |
| 7. | Whether checking of reinforcement done for adequacy of cover maintaining spacing uniformity and rigidity. | Yes/No |

**C. FORMWORK AND WATER STOPS AND STEEL ITEMS :**

| | | |
|---|---|---|
| 8. | Whether the erection of form work, placement of water stop and joints are as per the requirement. | Yes/No |
| 9. | Whether geometry of form work and adequacy of supporting system is checked. | Yes/No |
| 10. | Whether form work joints are properly sealed | Yes/No |
| 11. | Whether the Oiling of forms is done adequately. | Yes/No |
| 12. | Whether the concrete mixes, their location and sequence of placement satisfactory. | Yes/No |
| 13. | Whether the transporting units, placement units and vibrators are sufficient and adequate. | Yes/No |
| 14. | Whether Curing arrangements are adequate ? | Yes/No |
| 15. | Slump = | |
| 16. | No. of cubes cast | |

Signature of Contractor Sign. of A.E./AAE Deputy Ex. Engr.

D.E.E../ A.E./A.A.E. Sign. of inspecting Officer

**Name of Dn.** :

**Name of Sub Dn.** :

**O.K. CARD FOR C.C. LINING**

Location: Chainage from …… to ……

Distance from Centre line : Date :

| | | | | |
|---|---|---|---|---|
| 1. | Whether sub grade is Okay from geometric angle? | Yes/No | | |
| 2. | whether sub grade is prewetted sufficently before placing the concrete? | Yes/No | | |
| 3. | Density and moisture content of sub grade | | | |
| 4. | Date and time of appoval of sub grade | | | |
| 5. | Date and time of starting C.C. Lining. | | | |
| 6. | Whether Paver machine is Okay and it's alignments set? | Yes/No | | |
| 7. | Whether the levels of rails are checked? | Yes/No | | |
| 8. | Whether placing arrangement of concrete is proper (i.e. sufficiency of lining equipments and transit mixers) | Yes/No | | |
| 9. | Workability of concrete at placement/B.M. Plant | slump | M.M. | _____ |
| 10. | Whether No. of labourers, masons etc.are adequate ? | Yes/No | | |
| 11. | Are curing arrangements adequate and satisfac tory? | Yes/No | | |
| 12.A | Whether PVC strips to be inserted is checked W.R.T. quality and quantity | Yes/No | | |
| B | Whether PVC strip insertion is made? | | | |
| C | Whether proper cutting of joints has been done ? | | | |
| 13. | Whether log book of paver machine is maintained ? | Yes/No | | |
| 14.A | Whether curing compound to be used is tested ? | | | |
| B | Specify results with coverage. | | | |
| 15. | No. of cube cast | | | |
| 16. | Date and time of completion of lining | | | |
| 17. | Remarks : | | | |

Sign. of Contractor Sign.of AE/AAE Deputy Exe. Engineer

D.E.E./A.E./A.A.E.
Quality Control Su b-Dn.

Sign. of Inspecting Officer

Name of Division :
Name of sub-Division :
Name of canal :

**O.K. CARD FOR SUB GRADE OF C.C. LINING**

Location: Chainage From …… to ……..

Distance from Central Line : Date :

| | | |
|---|---|---|
| 1. | Whether proud has been removed before commencement of C.C. lining as per specifications? | Yes/No |
| 2. | Whether final levels after proud removal are within the tolerance limits? | Yes/No |
| 3. | Over excavation, if any, may be specifically indicated. | |
| 4. | Whether final levels have been recorded | Yes/No |
| 5. | Whether mapping of rock/soil is done | Yes/No |
| 6. | Whether filling in over excavation is carried out? | Yes/No |
| 7. | Whether sub grade has been properly watered compacted as per design? | Yes/No |
| 8. | Depth of moisture in the sub grade after watering. | |
| 9. | Whether designed under drainage arrangements are provided? (e. g. P.R.V.., longitadinal & cross drains) | Yes/No |
| 10. | Whether necessary approval of sub grade is taken? Result of test, % compaction & % of FMC | Yes/No |
| 11. | Instruction of inspecting officer if any. | |

Sign. of Contractor Sign. of AE/AAE Deputy Exec. Engineer

D.E.E./A.E/A.A.E.
Quality Control Sub-Dn. No. Sign. of Inspecting Officer.

Name of Dn. :
Name of sub-Division :

**O.K. CARD FOR SUB GRADE OF BRICK LINING**

LOCATION CHAINAGE from to
Date :-

| | | |
|---|---|---|
| (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? Results of tests | Yes/No |
| | % age of compaction | - |
| | % age of FMC | - |
| 7. | Whether sub grade is okay from geometrical angle and necessary templates are provided ? | |
| 8. | Remarks | |

Sign. of Contractor Sign. of A.E/A.A.E Deputy Executive Engineer
Sub-Dn

D.E.E/A.E./A.A.E.
Quality Control Sub-Dn

Sign. of Inspecting Officer

Name of Division :
Name of sub-Division :
Name of canal :

**O.K. CARD FOR BRICK LINING**

LOCATION Chainage from to
Date :-

| | | |
|---|---|---|
| (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 seperately? | 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? Brand of cement, Grade, and Batch No. | Yes/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 motar ? 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 consistancy 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 levelling 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 mortar between the joint space checked ? | Yes/No |
| 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 |

Sign. Of contractor  Sign. Of AE/AAE  Deputy Ex. Engineer

D.E.E/A.E./A.A.E.
Quality Control Sub-Dn

Sign. of Inspecting Officer

| Sr.No. | Standard No. | TITLE |
|---|---|---|
| **1.00** | **CEMENT :** | |
| 1.1 | IS : 269:1989 | Specification for 33 grade ordinary portland cement (Fourth) Revision) |
| 1.2 | IS : 455:1989 | Portland blast furnace slag cement. (Fourth revision) Amed-3. |
| 1.3 | IS : 1489: 1991 | Specification for Portland Pozzolona Cement (Third revision) Flyash based. |
| 1.4 | IS : 3466:1988 | Specification for masonry cement (Second revision) |
| 1.5 | IS : 3535:1986 | Methods of Sampling hydraulic cement (First revision) |
| 1.6 | IS : 4031(part-I)-1988 | Methods of physical tests for hydraulic cement - Determination of fineness by dry sieving. (First revision) |
| 1.6.2 | (Part-2) : 1998 | --do – Determination of fineness by specific surface by blaine air permiability (First revision) |
| 1.6.3 | (Part-3) : 1988 | -- do --Determination of soundness (First revision) |
| 1.6.4 | (Part-4) : 1988 | -- do -- Determination of consistency of sand and cement paste (First revision) |
| 1.6.5 | (Part-5) : 1988 | -do-Determination of initial and final setting time (First revision) |
| 1.6.6 | (Part-6) : 1988 | -- do --Determination of comp. strength of hydraulic cement other than masonry cement (First revision) |
| 1.6.7 | (Part-7) : 1988 | -- do -- Determination of Comp. strength of masonry cement (First revision) |
| 1.6.8 | (Part-8) : 1988 | -- do -- Determination of transverse and Comp. stren. of plastic mortar using prism (First revision) |
| 1.6.9 | (Part-9) : 1988 | -- do -- Determination of heat of hydraytion. (First revision) |
| 1.6.10 | (Part-10) : 1988 | -- do -- Determination of drying shrinkage ( First revision) |
| 1.6.11 | (Part-11) : 1988 | -- do -- Determination of density (First revision) |
| 1.6.12 | (Part-12) : 1988 | -- do -- Determination of air content of hydraulic cement mortar. (First revision) |
| 1.6.13 | IS:4031 (Part-13):1988 | -do-Determination of measurement of water retentivity of masonary cement. (First revision) |
| 1.6.14 | 4031 (Part-14) : 1989 | -do- Determination of False test. |
| 1.6.15 | IS:4031 (Part-15):1991 | -d0- Determination of fineness by wet sieving. |
| 1.7 | IS:4032:1986 | Methods of chemical analysis for hydraulic cement (First revision) |
| 1.8 | IS:4905:1968 | Methods for random sampling Amed – 1, Reaff – 1991. |
| 1.10 | IS:6909:1990 | Specification for super sulphated cement Amed –2. |
| 1.11 | IS:8041:1990 | Rapid hardning cement. |
| 1.12 | IS:8042:1989 | White Portland cement. |
| 1.13 | IS:8112:1989 | 43 Grade Ordinary Portland Cement Specification Amed – 3. |
| 1.14 | IS:12269 – 1987 | Specification for 53 grade ordinary Portland cement. Amed-3. |
| 1.15 | IS:12330-1988 | Specification for sulphate resisting Portland cement Amed-3. |
| **2.00** | **POZZOLANA :** | |
| 2.1 | IS : 1344 : 1981 | Specification for calcined clay pozzolana Second revision)Amed–1. |
| 2.2 | IS : 1727 : 1967 | Method of test for Pozzolanic materials (First revision) Amed-1, Reaff – 1990. |
| 2.3 | IS : 3812 : 1981 | Specification for fly ash for use as pozzolana and admixture (First revision) Reaff-1992. |
| 2.4 | IS:6491:1981 | Method of Sampling of Flyash. |
| 2.5 | IS : 10153 :1982 | Guidelines for utilisation and disposal for Flyash. |
| **3.00** | **BUILDING LIME :** | |
| 3.1 | IS:712:1984 | Specification for building limes.(Third revision)Amed (Reaff-1995) |
| 3.2 | IS:1128:1974 | Specification for limestone. (Slab & tiles ) (First revision) Reaff-1993. |
| 3.3 | IS : 1624 : 1986 | Method of field testing of building lime (First revision) Amed-1, Reaff – 1993. |
| 3.4 | IS : 3115 :1992 | Lime based blocks. (Second revision) |
| 3.5 | IS : 4095 : 1983 | Lime pozzolana mixture. (First revision) Amed – 2, reaff – 1989. |

| | | |
|---|---|---|
| 3.6 | IS : 6508 : 1988 | Glossary of terms relating to building lime (first revision) Reaff-1993. |
| 3.7 | IS : 6932 : 1973 | Methods of test for building limes. |
| 3.7.1 | IS : 6932(Part – I):1973 | Determination of insoluble Residue, loss on ignition, butyric and aluminium oxide calcium oxide and magnesium oxide Reaff-1995. |
| 3.7.2 | IS : 6932(Part – 2):1973 | -- do --Determination of Carbon dioxide content Reaff – 1990. |
| 3.7.3 | IS : 6932(Part-3) : 1973 | -- do --Determination of Residue on Slaking of quick lime. Reaff-1995. |
| 3.7.4 | IS : 6932(Part-4) : 1973 | -- do --Determination of fineness of Hydraulic lime. Reaff-1995. |
| 3.7.5 | IS : 6932(Part-5):1973 | -- do --Determination of unhydrated oxide. Reaff-1995. |
| 3.7.6 | IS:6932( Part-6):1973 | -- do --Determination of volume-yield of quick lime Reaff-1995. |
| 3.7.7 | IS:6932(Part-7):1973 | -- do --Determination of compressive and transverse strength. Reaff-1995. |
| 3.7.8 | IS:6932:(Part-8):1973. | -- do -- Determination of workability Reaff-1995. |
| 3.7.9 | IS:6932(Part-9):1973 | -- do --Determination of soundness. Reaff – 1995. |
| 3.7.10 | IS:6932 (Part-10):1973:. | -do-Determination of poping and pitting of hydrated lime.Reaff-1995. |
| 3.7.11 | IS:6932 (Part-11):1984:. | -- do -- Determination of setting time of hydrated lime. Reaff-1990. |
| **4.00** | **STRUCTURAL STEEL:** | |
| 4.1 | IS:432(Part-I):1982 | Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement Part-I Mild steel. (Third revision Reaff. 1995) |
| 4.2 | IS:432(Part-II):1982 | Specification for mild steel and Medium tensile steel bars and hard drawn steel wire for concrete reinforcement Part-2 hard drawn steel wire (Third revision) Reaff-1995. |
| 4.3 | IS:1566:1982 | Hard drawn steel wire fabric for concrete reinforcement (Secomd revision) Amed-2, Reaff-1995. |
| 4.4 | IS:1599:1985 | Method for bend test (supersiding IS:1962-1974. IS:3260-1960 and IS:4598:1965) Reaff-1991. |
| 4.5 | IS:1608:1995. | Method for tensile testing of steel product (Second revision) |
| 4.6 | IS:1785(Part-I):1983 | Specification for plain hard drawn steel wire for pre-stressed conc. to part-I cold drawn stress relieved wire (Second revision) Amed-1, Reaff-1995. |
| 4.7 | IS:1785(Part-II):1983 | Specification for plain hard drawn steel wire for pre stressed concrete Part-2 a cold drawn wire (First revision) Amed-1, Reaff-1995. |
| 4.8 | IS:1786:1985 | Specification for high strength deformed steel bars and wires for concrete reinforcement (Third revision) Amed-1, Reaff-1990. |
| 4.9 | IS:1977:1966 | Low tensile structural steel (Third revision) |
| 4.10 | IS:2062:1992 | Steel for general structural purposes (Fourth revision) Amed-1. |
| 4.11 | IS:2090:1983 | High tensile steel bars for concrete reinforcement. (Third revision, Reaffirmed – 1990. |
| 4.12 | IS:8500:1991 | Structural steel medium & high strength qualities(first revision Amed-2. |
| 4.13 | IS:6003-1983 | Indented wire for prestressed concrete (first revision) |
| 4.14 | IS:6006-1983 | Specification for uncoated stress relived strend for prestressed concrete (first revision) |
| 4.15 | IS:13620-1993 | Fusion bonded epoxy coated reinforcing bars (amend - 1) |
| **5.0** | **BUILDING STONE :** | |
| 5.1.1 | IS:1121(Part-I):1974 | Method of test for determination of |

| | | |
|---|---|---|
| | | strength properties of natured building stones. Compressive strength (First revision) Amed-1, Reaff-1993. |
| 5.1.2 | IS:1121(Part-2):1974 | -do- Transverse strength. (First revision) Reaff-1993. |
| 5.1.3 | IS:1121(Part-3):1974 | -do Tensile strength (First revision) Reaff-1993. |
| 5.1.4 | IS:1121(Part-4):1974 | -do Shear strength (First revision) Reaff-1993. |
| 5.2 | IS:1122:1974 | Method of test for determination of true specific gravity of natural building stones (First revision) Reaff-1993. |
| 5.3 | IS:1123;1975 | Identification of Petrographic examination of natural building stone. First revision Reaff. 1990. |
| 5.4 | IS:1124:1974 | Method of test for determination of water absorption apparent sp. gr. and porosity of natural building stone(First revision) Reaff-1990. |
| 5.5 | IS:1125:1974 | Method of test for determination of weathering of natural building stone(First revision) Reaff-1990. |
| 5.6 | IS:1126:1974 | Method of test for determination of durability of natural building stone (First revision) Amed-1, Reaff-1990. |

**6.00 AGGREGATE :**

| | | |
|---|---|---|
| 6.1 | IS:383:1970 | Specification for coarse and fine aggregate material (Second revision) Reaff-1990. |
| 6.2 | IS:1542:1992 | Sand for plasters (Second revision) |
| 6.3 | IS:2116:1980 | Sand for masonry mortars (First revision) Reaff-1992 |
| 6.4.1 | IS:2386(Part-I):1963. | Method of test for aggregate for concrete, Particle size and Shape, |
| 6.4..2 | IS:2386(Part-2):1963. | -- do --Estimation of deleterious material and organic impurities. Amed-1, Reaff-1990. |
| 6.4..3 | IS:2386(Part-3):1963. | -do- Specific gravity density voids, absorption and bulking. Reaff-1990. |
| 6.4..4 | IS:2386(Part-4):1963. | -- do --Mechanical properties. Amed-5, Reaff-1990. |
| 6.4..5 | IS:2386(Part-5):1963. | -- do --Soundness, Reaff-1990. |
| 6.4..6 | IS:2386(Part-6):1963. | -- do -- : Measuring mortar making properties of fine aggregate. Amed – 2, Reaff-1990. |
| 6.4..7 | IS:2386(Part-7):1963 | -- do --Alkali aggregate reactivity, Reaff-1990. |
| 6.5 | IS:2430:1969 | Method for sampling of aggregate for concrete. |
| 6.6 | IS:5640:1970 | Method of test for determining aggregate impact value of soft coarse aggregates. Amed-1. Reaff – 1990. |

**7.00 BRICKS :**

| | | |
|---|---|---|
| 7.1 | IS:654:1992 | Specification for clay roofing rooting tiles mangalore pattern (Third revision) |
| 7.2 | IS:1077:1992 | Specification for common burnt clay building bricks (Fifth revision) |
| 7.3 | IS:2117:1991 | Guide for manufacture of hand made burnt clay building bricks (Third revision) |
| 7.4 | IS:2248:1992 | Glossary of terms relating to structural clay products for building (First revision) |

| | | |
|---|---|---|
| 7.5 | IS:3495:1992(Part-I to 4) -1992 | Method of test for burnt clay building bricks Part-1 to 4 (Third revision) |
| 7.6 | IS:4860:1968 | Specification for acid resistant bricks Reaff-1991. |
| 7.7 | IS:5454:1978 | Method of sampling of clay building bricks (First revision) Reaff-1995. |
| 7.8 | IS:6165:1992 | Dimensions for special shapes of clay bricks (First revision) |
| **8.00** | **TILES :** | |
| 8.1 | IS:1237:1980 | Specification for cement flooring tiles (First revision) Reaff-1990. |
| 8.2 | IS:1464:1992 | Clay ridge and ceiling tiles specification (Second revision) |
| 8.3 | IS:2690(Part-1&2):1992 | Burnt clay flat terracing tiles (Second revision) |
| 8.4 | IS:4457:1982 | Specification for ceremic unglazed vitreous acid resisting tile (First revision ) Reaff-1990. |
| **9.00** | **LDPE FILM:** | |
| 9.1 | IS:2508:1984 | Low density polythelene films (Second revision) Amed-1, Reaff-1990. |
| **10.00** | **TIMBER :** | |
| 10.1.1 | IS:1708(Part-1):1986 | Method of testing of small clear specimen of timber Determination of moisture content. (Second revision) Reaff -1991. |
| 10.1.2 | IS:1708(Part-2):1986 | -do- Determine of specific gravity (Second revision) |
| 10.1.3 | IS:1708(Part-3):1986. | -do- Determination of volumetric Shrinkage.(Second revision) |
| 10.1.4 | IS:1708(Part-4):1986. | -do- Determination of radial and tangential shrinkage and fibre saturation point. (Second revision) |
| 10.1.5 | IS:1708(Part-5):1986. | -do- Determination of static bending strength under two points loading. (Second revision) |
| 10.1.6 | IS:1108(Part-6):1986. | -do- Determination of static bending strength under 2 point loading. (Second revision) |
| 10.1.7 | IS:1708(Part-7):1986. | -do- Determination of impact bending strength (Second revision) |
| 10.1.8 | IS:1708(Part-8):1986. | -do- Determination of compressive strength parallel to grain (Second revision) |
| 10.1.9 | IS:1708(Part-9):1986. | -do- Comp. strength perpendicular to grain. (Second revision) |
| 10.1.10 | IS:1708(Part-10):1986. | -do- Determination of hardness under static identification (Second revision) |
| 10.1.11 | IS:1708(Part-11):1982 | -do- Determination of sheer strength parallel to grain (Second revision) |
| 10.1.12 | IS:1708(Part-12):1986 | -do- Determination of tensile strength parallel top grains. (Second revision) |
| 10.1.13 | IS:1708(Part-13):1986. | -do- Determination of tensile strength perpendiculer to grain (Second revision) |
| 10.1.14 | IS:1708(Part-14):1986. | -do- Determination of clear age strength parallel to grain. (Second revision) |

| | | |
|---|---|---|
| 10.1.15 | IS:1708(Part-15):1986. | -do- Determination of Nail screw holding power (Second revision) |
| 10.1.16 | IS:1708(Part-16):1986. | -do- Determination of brittleness by Izod impact (Second revision) |
| 10.1.17 | IS:1708(Part-17):1986. | -do- Determination of brittleness of carphy impact. (Second revision) |
| 10.1.18 | IS:1708(Part-18):1986. | -do- Determination of torsional strength (Second revision) |
| 10.2 | IS:2202(Part-1):1991. | Specification for flush door shutters solid core type) (Fifth revision(Amed – 3. |
| 10.3 | IS:2408;1963 | Methods of static tests of timber in structural sizes. Amedment-1, Reaff1990. |
| 10.4 | IS:4970:1973 | Key for identification of commercial timber (First revision) |
| **11.00** | **ADMIXTURE :** | |
| 11.1 | IS:2645:1975 | Specification for integral cement water proofing compound. (First revision) Amed-1, Reaff-1992. |
| 11.2 | IS:9103:1979 | Specification for Admixture for concrete (first revision) Reaff-1990. |
| **12.00** | **CONCRETE :** | |
| 12.1 | IS:456:2000 | Code of practice for plain and reinforced concrete (Third revision) Amed-2, Reaff.1991. |
| 12.2 | IS:457:1957 | code of practice for general construction of plain and reinforced concrete for dams and other massive structure. Reaff-1991. |
| 12.3 | IS:458:1988 | Concrete pipes. (Third revision) Amed-2. |
| 12.4 | IS:516:1959 | Method test for strength of concrete. Amed-2, Reaff -1991. |
| 12.5 | IS:1199:1959 | Methods of sampling and analysis of concrete. Reaff - 1991. |
| 12.6 | IS:1791:1985 | General requirements for batch type concrete mixtures (Second revision.) |
| 12.7 | IS:1834:1984 | Hot applied sealing compounds for joints in concrete(First rev.) |
| 12.8 | 1838(Part1.2)1983/1984 | Preformed fillers for expansion tests in concrete pavement and structures (non extruding & resitient type) |
| 12.9.1 | IS:2185(Part-1):1979. | Specification for concrete for masonry units part-1. Hollow and solid concrete (Second revision) Amed-1, Reaff-1992. |
| 12.9.2 | IS:2185(Part-2):1983 | Specification for concrete masonry units, Part-2 Hollow and solid light weight concrete blocks (first revision) Reaff-1995. |
| 12.9.3 | IS:2185(Part-3):1984 | Specification for concrete masonry units part-3, Autoclave cellular aerated concrete blocks (First revision) Reaff-1990. |
| 12.10 | IS:3085:1965 | Methods of tests for permeability of cement mortar and concrete. Reaff-1990. |
| 12.11 | IS:3597:1985 | Method of testing for concrete pipes. (first revision) Reaff 1990. |
| 12.12 | IS:3860:1966 | Precast cement concrete slabs for canal linings. |
| 12.13 | IS:3873;1978 | Code of practice for laying insitu cement concrete lining on canals (First revision.) |
| 12.14 | IS:4926;1976 | Ready mixed concrete (First revision.) |

| | | |
|---|---|---|
| 12.15 | IS:4969:1968 | Method of test for determining flexural strength of precast cement concrete slabs for canal lining. |
| 12.16 | IS:9012;1978. | Recommended practice for shotcreting (Reaff - 1987) |
| 12.17 | IS:10262:1982 | Recommanded guideline for concrete mix design. Reaff-1989. |
| **13.00** | **MASONARY MORTAR :** | |
| 13.1 | IS:2116:1980 | Specification of sand for masonary mortars (First revision) Reaff-1992. |
| 13.2 | IS:2250:1981 | Code of practice for preparation and use of masonry mortars. (First revision) Reaff-1990. |
| **14.0** | **Sealing Compound** | |
| 14.1 | IS:5256:1968 | Code of practice for sealing joints in concrete lining on canals. |
| 14.2 | IS:13143;1991 | Joints in concrete lining of canals-sealing compound – specifications. |
| **15.0** | **WATER (For construction)** | |
| 15.1 | IS:456:2000 | Code of practice for plain and reinforced concrete. (Third revision) Amed – 2, Reaff-1991 |
| 15.2 | IS:3025;Part 1,3,9 to 12,14, to 19,21 to 26,32) | Methods of sampling and test (physical and chemical for water and waste water.) |
| **16.00** | **CURING COMPOUND** | |
| 16.1 | ASTM-C-309-1989 | Specificatin for liquid membrane forming compounds for curing concrete. |
| 16.2 | C-156-1989 | 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 methode for color anf color difference measurements by Tristimulus (filter) Colorimetry. |
| **17.00** | **PVC Water Stops** | |
| 17.1 | IS:8543(Part-4)-1984 | Method of testing plastics. |
| 17.2 | IS:12200-1987 | Code of practice for provision of water stops at transverse contraction joints in masonry & concrete dams. |
| 17.3 | ASTM:D:638:1991 | Test for tensile properties of plastics |
| 17.4 | ASTM:D:412:1992 | Test for rubber properties in tension |
| 17.5 | ASTM:D:2240:1990 | Test for rubber property Durometer hardness |