Handout on Indian Standards on Building Materials

Bureau of Indian Standards

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About Bureau of Indian Standards

Bureau of Indian Standards (BIS) is the National Standard Body of India established under the BIS Act 2016 for the harmonious development of the activities of standardization, marking and quality certification of goods and for matters connected therewith or incidental thereto. BIS has been providing traceability and tangibility benefits to the national economy in a number of ways – providing safe reliable quality goods; minimizing health hazards to consumers; promoting exports and imports substitute; control over proliferation of varieties etc. through standardization, certification and testing.

Keeping in view, the interest of consumers as well as the industry, BIS is involved in various activities as given below:

- Standards Formulation
- Product Certification Scheme
- Compulsory Registration Scheme
- Foreign Manufacturers Certification Scheme
- Hall Marking Scheme
- Laboratory Services
- Laboratory Recognition Scheme
- Sale of Indian Standards
- Consumer Affairs Activities
- Promotional Activities
- Training Services, National & International level
- Information Services

The Bureau is a Body Corporate consisting of 25 members representing both Central and State governments, Members of Parliament, industry, scientific and research institutions, consumer organizations and professional bodies; with Union Minister of Consumer Affairs, Food and Public Distribution as its President and with Minister of State for Consumer Affairs, Food and Public Distribution as its Vice-President.

BIS also represents India as a member country in International Organization for Standardization (ISO). It is actively involved in the development of International

Standards by acting as Participating (P) or Observer (O) member in various ISO technical committees, Sub-committees and Working Groups.

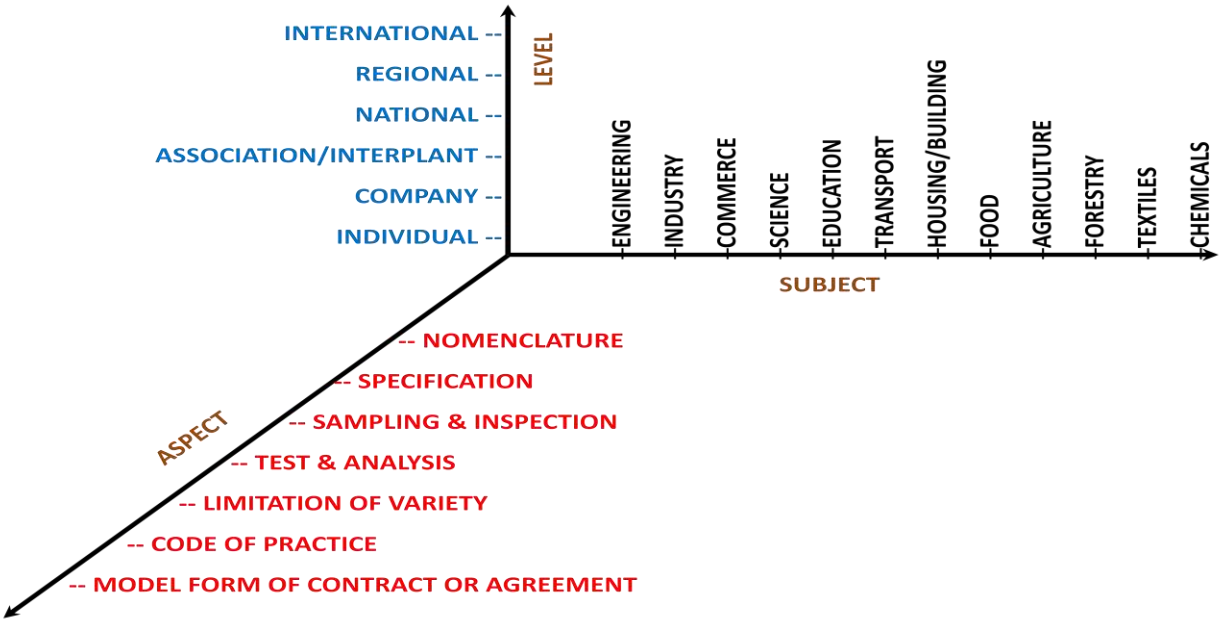
What are 'Standards' ?

Standard is a document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

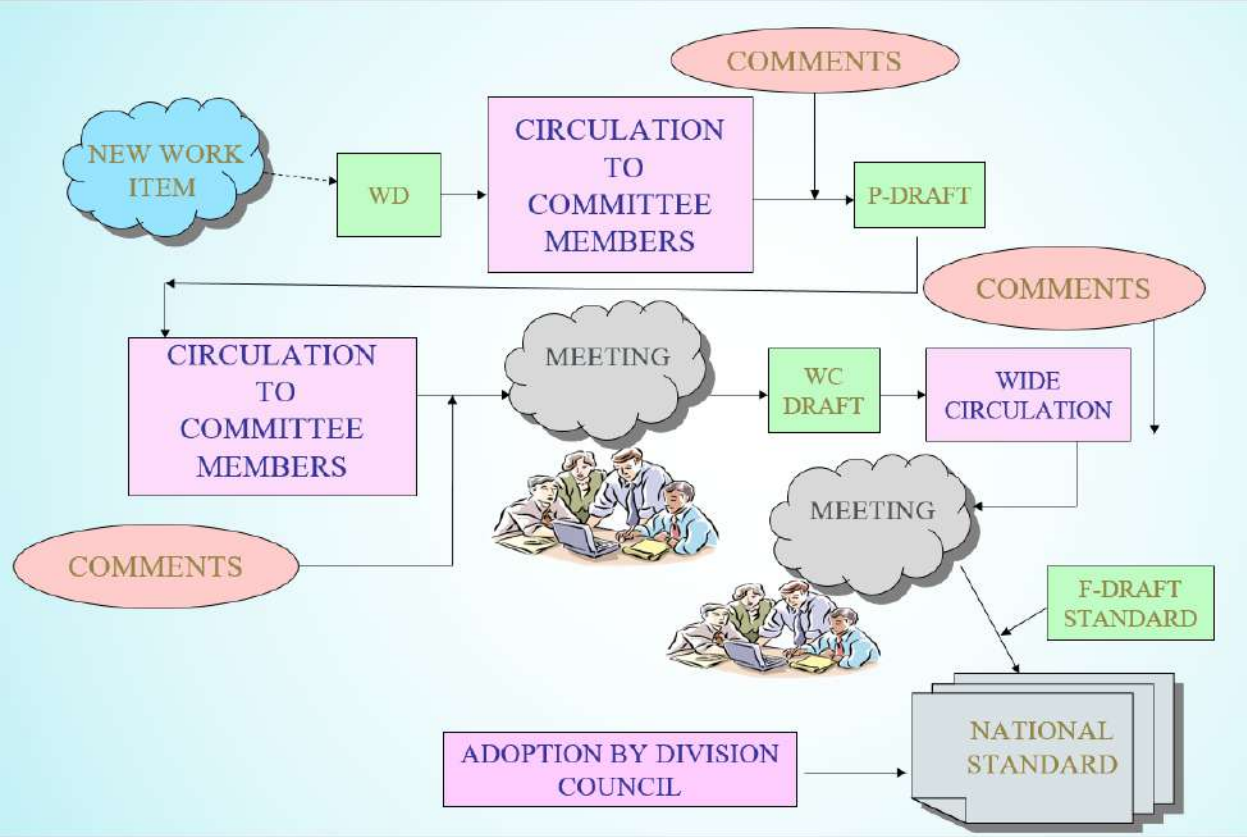
Importance of Standardization

Standardization is the process of developing technical standards through consensus of different parties. This standardization aims to address one or all of compatibility, interchangeability, variety control, safety, environment protection, product protection and fitness for purpose. Standards provide numerable benefits to the technologists, producers, consumers and traders besides defining purpose for each of these entities.

Standards can be formulated at various levels ranging from an individual to National (IS) through to International level (ISO). Also, depending on the subject in hand, standards can be made on various aspects such as terminology, specification, sampling, testing, code of good practice, model form of contract. A typical depiction of the standardization space is illustrated below:



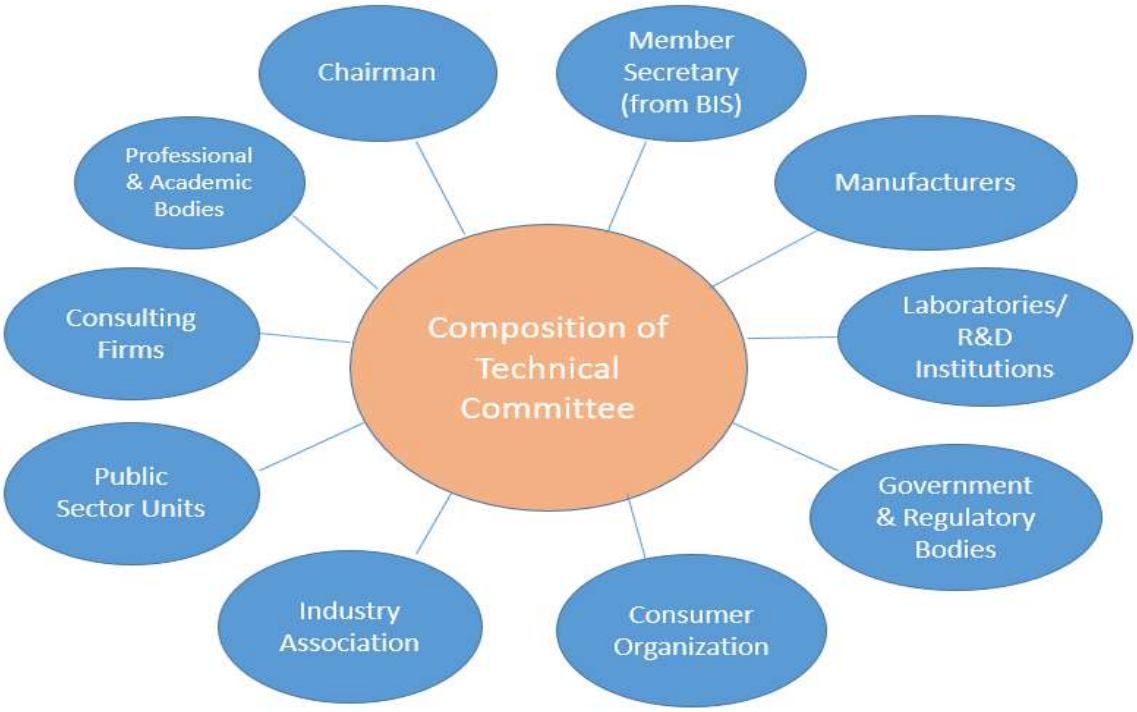
BIS Standards Formulation Process

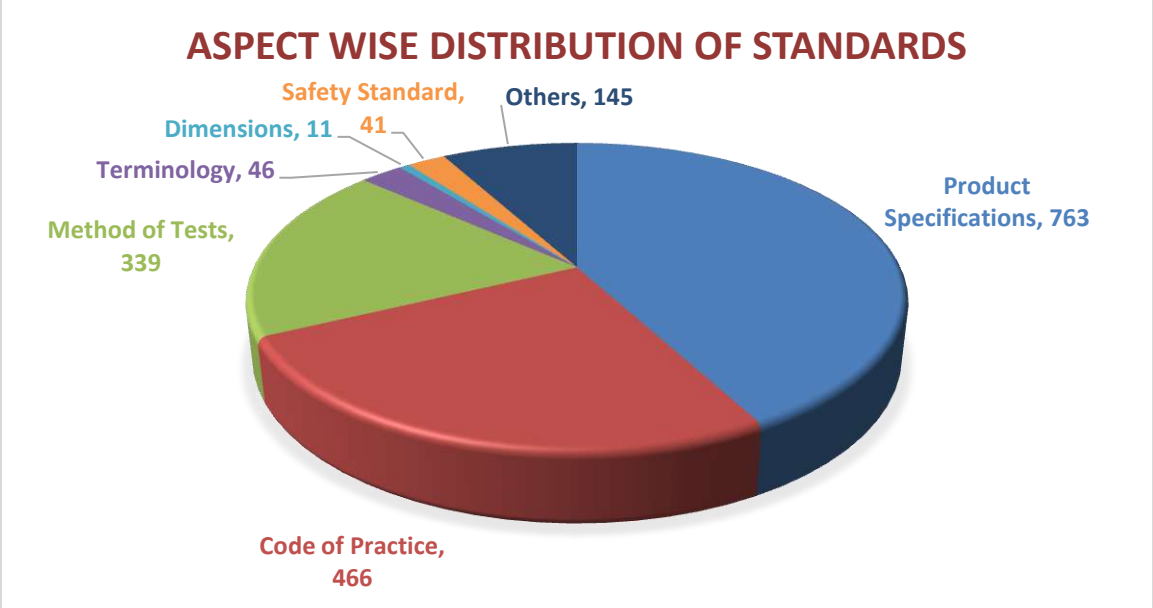


Nationally, the Bureau of Indian Standards (BIS) establishes the National Standards commonly known as Indian Standard (IS) apart from Special Publications (SP).

Introduction to Civil Engineering Department (CED)

Indian Standards related to civil engineering are dealt by Civil Engineering Division Council (CEDC) of BIS. At present, there are 38 Technical Committees under CEDC. Total number of standards published by CEDC (as of March 2022) are **1811**.


Composition of Technical Committee
Chairman
Member Secretary (from BIS)
Manufacturers
Laboratories/ R&D Institutions
Government & Regulatory Bodies
Consumer Organization
Industry Association
Public Sector Units
Consulting Firms
Professional & Academic Bodies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Handout on Building Materials

Building materials form a basic component of any built structure. Towards ensuring safe and robust structure, the quality of such materials is important. Standards play an important role in defining such requirements and to establish them in practice.

Innumerable numbers of materials are used in building construction and several hundreds of Indian Standards have been listed in the Building Materials chapter of the National Building Code of India 2016.

BIS has formulated various standards on some of the frequently used building materials as listed below:

- Cement
- Aggregate
- Concrete
- Reinforcing and Prestressing Steel
- Bricks and Blocks
- Timber and Plywood
- Innovative Materials

Cement

A cement is a binding material which is most widely used in building and civil engineering construction. When mixed with water, it sets and hardens. It is formed from argillaceous (containing silica) and calcareous (containing calcium) rocks. Composition of cement includes lime (65%), silica (20%), alumina (3-5%), magnesia (1-3%), iron oxide (0.5-6%), alkalies (0.5-1%) and Sulphur trioxide (1-3%). It is mainly classified as Hydraulic and Non-hydraulic cement.

A total of 16 Indian Standards on hydraulic cement is currently available of which 15 standards can be used for both buildings and structures.

Sl No.	IS Code	Year of publication	Title
1	IS 269	2015	Ordinary Portland cement — Specification (*sixth revision*)
2	IS 455	2015	Portland slag cement — Specification (*fifth revision*)
3	IS 1489 (Part 1)	2015	Portland pozzolana cement — Specification: Part 1 Flyash based (*fourth revision*)
4	IS 1489 (Part 2)	2015	Portland pozzolana cement — Specification: Part 2 Calcined clay based (*fourth revision*)

5	IS 3466	1988	Specification for masonry cement (*second revision*)
6	IS 6452	1989	Specification for high alumina cement for structural use (*first revision*)
7	IS 6909	1990	Specification for supersulphated cement (*first revision*)
8	IS 8041	1990	Specification for rapid hardening Portland cement (*second revision*)
9	IS 8042	2015	White Portland cement — Specification (*third revision*)
10	IS 8043	1991	Specification for hydrophobic Portland cement
11	IS 8229	1986	Specification for Oil-well Cement
12	IS 12330	1988	Specification for sulphate resisting Portland cement
13	IS 12600	1989	Specification for low heat Portland cement
14	IS 16415	2015	Composite cement — Specification
15	IS 16993	2018	Microfine ordinary Portland cement — Specification
16	IS 15895	2018	High alumina refectory cement — Specification

The Indian Standards on cement specify the list of basic raw materials, options of manufacture (by inter grinding process or by inter blending process), the physical requirements, chemical requirements, the associated Indian Standard test method to determine the requirements. Typically the physical requirements spelt out to be met in line with the necessary test method standard cover the following:

- Fineness (IS 4031 Part 2)
- Setting time (IS 4031 Part 5)
- Compressive strength (IS 4031 Part 6)
- Transverse strength (IS 4031 Part 8) *optional*
- Soundness (IS 4031 Part 3)

The chemical requirements spelt out to be met by any cement in line with the necessary test method standard cover the following:

- Lime saturation factor
- Insoluble residue
- Magnesia
- Sulphate content
- Loss on ignition
- Chloride content
- Alumina/Iron oxide

Such cement conforming to the Indian Standard require to be delivered in specified bags/containers; the requirements for marking on such bags have also been listed in the cement standards to cover also the following:

- Type of cement
- Performance improver
- Name and address of manufacturer with his trademark
- Batch/control number (Date/week/month of manufacturer)
- Net quantity of cement
- Best before date (3 months)
- Aggregates

Aggregates

Aggregates are important components for making concrete and properties of concrete are substantially affected by various characteristics of the aggregates used. Aggregates from natural sources form the major variety used for making concrete, mortar and other applications. Based upon their size, they are categorized as coarse and fine aggregates.

Coarse and fine aggregates are the two essential ingredients for making concrete. The Indian Standard IS 383 : 2016 'Coarse and fine aggregates for concrete — Specification (third revision)' covers both naturally sourced aggregates as well as those manufactured as a by product from industries. This standard covers fine aggregates that are 4.75 mm and below in size which can be any of:

- Natural sand
- Crushed sand (stone sand and gravel sand)
- Mixed sand
- Manufactured fine aggregate (commonly known as manufactured sand)

The coarse aggregates specified in IS 383 covers those aggregates more than 4.75 mm which can be from any of:

- Uncrushed gravel/stone
- Crushed gravel/stone
- Partially crushed gravel/stone

Manufactured from other than natural sources (by processing/thermal means). Recycled concrete aggregated (RCA) and recycled aggregated (RA) comes under this category.

IS 383 also cover all-in-aggregates which comprises both fine aggregate and coarse aggregates in a single mixture.

Concrete

It is the most widely used building construction material used all across the world and building block of the modern infrastructure. Concrete is a composite material formed by mixing cement, water, fine and coarse aggregates, and admixtures. Concrete mix design is a method of determining the right proportions of cement, water, sand and aggregates in order to achieve the required target strength. The proportioning is carried out to achieve specified characteristics at specified age, workability of fresh concrete and durability requirements. IS 10262: 2019 provides the guidelines for concrete mix proportioning. This standard has been divided into five sections as follows:

1. Section 1 General
2. Section 2 Ordinary and standard grades of concrete
3. Section 3 High strength grades of concrete
4. Section 4 Self compacting concrete
5. Section 5 Mass concrete

The consideration of air content in design of normal (non-air entrained) concrete mix proportion, has been reintroduced in this standard.

Table 6 Approximate Air Content
(*Clause* 6.2.3)

Sl No.	Nominal Maximum Size of Aggregate mm	Entrapped Air, as Percentage of Volume of Concrete
(1)	(1)	(1)
i)	10.0	1.0
ii)	12.5	0.8
iii)	20.0	0.5

Section 3 High strength grades of concrete

High strength concrete is the concrete that has characteristic compressive strength of 65 N/mm2 or more. This section provides the guidance for selecting mix proportion for M65 or above. Usually, for high strength concrete mixes specially selected cementitious materials and chemical admixtures, that is, super plasticizers are used, and achieving a low water–cementitious materials ratio (w/cm) is considered essential.

Section 4 Self compacting concrete

Self compacting concrete (SCC) may be used in precast concrete applications or for concrete placed on site. SCC is used to cast sections with highly congested reinforcement and in areas that present restricted access to placement and consolidation, including the construction of tunnel lining sections and the casting of hybrid concrete filled steel tubular columns. It may be manufactured in a site batching plant or in a ready-mixed concrete plant and delivered to site by truck mixer. It may be placed either by pumping or pouring into horizontal or vertical forms.

A concrete mix can only be classified as self compacting concrete, if the requirements for all below mentioned characteristics are fulfilled:

a) Filling Ability (Flowability),
b) Passing Ability,
c) Segregation resistance, and
d) Viscosity

The above tests shall be carried out as per IS 1199 (Part 6).

Section 5 Mass concrete

Mass concreting is used for structures like dams and other massive structures. For such large structures, measures need to be taken to cope with the generation of heat from hydration of cement and attendant volume change to minimize cracking.

The primary objective of proportioning for mass concrete is to establish economical mixes of proper strength, durability and permeability with the best combination of available materials that will provide adequate workability, easy placeability and least temperature rise after placement.

In mass concrete structures, generally lower grade of concrete (say M 15 or M 20) and higher sizes of coarse aggregates [maximum nominal size of aggregate (msa) 40 mm, msa 80 mm and msa 150 mm] are used. In certain cases, like thick raft foundation, retaining wall, etc, mass concreting may be of higher grade of concrete.

Tests on Fresh Concrete

Various stages in the manufacturing of concrete mix are listed below:

1) Batching
2) Mixing
3) Transportation
4) Placing
5) Compaction

6) Curing
7) Finishing

Tests on Fresh Concrete

Various tests on fresh concrete includes slump test, compacting factor test and vee-bee consistometer test which are used to measure the workability and fluidity of the concrete mix. IS 1199 is a series of standards dealing with methods of testing, sampling and analysis of fresh concrete. Its various parts are listed hereunder:

Sl No.	IS Code	Title
1	*IS 1199:1959	Methods of sampling and analysis of concrete
2	IS 1199 (Part 1):2018	Fresh Concrete – Methods of sampling, testing and analysis: Part 1 Sampling of fresh concrete (*first revision*)
3	IS 1199 (Part 2):2018	Fresh Concrete – Methods of sampling, testing and analysis: Part 2 Determination of consistency of fresh concrete (*first revision*)
4	IS 1199 (Part 3):2018	Fresh Concrete – Methods of sampling, testing and analysis: Part 3 Determination of density of fresh concrete (*first revision*)
5	IS 1199 (Part 4):2018	Fresh Concrete – Methods of sampling, testing and analysis: Part 4 Determination of air content of fresh concrete (*first revision*)
6	IS 1199 (Part 5):2018	Fresh Concrete – Methods of sampling, testing and analysis: Part 5 Making and curing of test specimens (*first revision*)
7	IS 1199 (Part 6):2018	Fresh Concrete – Methods of sampling, testing and analysis: Part 6 Tests on fresh self compacting concrete (*first revision*)
8	IS 1199 (Part 7):2018	Fresh Concrete – Methods of sampling, testing and analysis: Part 7 Determination of setting time of concrete by penetration resistance (*first revision*)
9	IS 14959 (Part 1):2001	Determination of water soluble and acid soluble chlorides in mortar and concrete — Method of test: Part 1 Fresh mortar and concrete

Tests on Hardened Concrete

Hardened concrete is the concrete that must be sufficiently strong to withstand design loads and must be durable enough for the estimated environmental risk. The properties of hardened concrete are listed below:

- Compressive strength
- Flexural tensile strength
- Split tensile strength
- Creep and shrinkage
- Rate of gain of strength

- Modulus of elasticity
- Permeability

Various standards for testing of hardened concrete are tabulated below:

Sl No.	IS Code	Title
1	*IS 516:1959	Methods of tests for strength of concrete
2	IS 516 (Part 1/Sec 1): 2021	Hardened concrete — Methods of test: Part 1 Testing of strength of hardened concrete: Section 1 Compressive, flexural and split tensile strength (*first revision*)
3	IS 516 (Part 2/Sec 1): 2018	Hardened concrete — Methods of test: Part 2 Properties of hardened concrete other than strength: Section 1 Density of hardened concrete and depth of water penetration under pressure (*first revision*)
4	IS 516 (Part 2/Sec 2): 2020	Hardened concrete — Methods of test: Part 2 Properties of hardened concrete other than strength: Section 2 Initial surface absorption (*first revision*)
5	IS 516 (Part 2/Sec 3): 2022	Hardened Concrete — Methods of test: Part 2 Properties of Hardened Concrete other than strength: Section 3 Oxygen permeability index (*first revision*)
6	IS 516 (Part 2/Sec 4): 2021	Hardened concrete — Methods of test: Part 2 Properties of hardened concrete other than strength: Section 4 Determination of the carbonation resistance by accelerated carbonation method (*first revision*)
7	IS 516 (Part 4):2018	Hardened concrete — Methods of test: Part 4 Sampling, preparing and testing of concrete cores (*first revision*)
8	IS 516 (Part 5/Sec 1): 2018	Hardened Concrete — Methods of test: Part 5 Non-destructive testing of concrete: Section 1 Ultrasonic pulse velocity testing (*first revision*)
9	IS 516 (Part 5/Sec 2): 2021	Hardened concrete — Method of test: Part 5 Non-destructive testing: Section 2 Half-Cell Potentials of uncoated reinforcing steel in concrete (*first revision*)
10	IS 516 (Part 5/Sec 3): 2021	Hardened concrete — Methods of test: Part 5 Non-destructive testing of concrete: Section 3 Carbonation depth test (*first revision*)
11	IS 516 (Part 5/Sec 4): 2020	Hardened concrete — Methods of test: Part 5 Non-destructive testing of concrete: Section 4 Rebound hammer test (*first revision*)
12	IS 516 (Part 6):2020	Hardened concrete — Methods of test: Part 6 Determination of drying shrinkage and moisture movement of concrete samples (*first revision*)
13	IS 516 (Part 8/Sec 1): 2020	Hardened concrete — Methods of test: Part 8 Determination of modulus of elasticity: Section 1 Static modulus of elasticity and poisson's ratio in compression (*first revision*)
14	IS 516 (Part 11):2020	Hardened Concrete — Methods of test: Part 11 Determination of Portland cement content of hardened hydraulic cement concrete (*first revision*)
15	IS 14959 (Part 2):2001	Determination of water soluble and acid soluble chlorides in mortar and concrete — Method of test: Part 2 Hardened mortar and concrete

Types of Concrete

Different types of concrete used in the construction industry are:

1. Self compacting concrete
2. Fibre reinforced concrete
3. Aerated concrete
4. Prestressed concrete
5. Ready mixed concrete
6. Structural light weight concrete
7. Refractory concrete
8. Pumped concrete

and many more.

IS 6461 (Part 4): 1972 – Glossary of terms relating to cement concrete Part 4 Types of concrete.

Non-Destructive Testing of Concrete

Non-destructive test is a method of testing existing concrete structures to assess the strength and durability of concrete structures. In this method of testing, we can measure strength of concrete without loading the specimen to failure (i.e. without destructing the concrete). Now days this method has become a part of quality control process. It also helps us to investigate crack depth, micro cracks and deterioration of concrete.

Non-destructive testing of concrete is a very simple method of testing but it requires skilled and experienced persons having some special knowledge to interpret and analyze test results.

Indian Standards related to NDT of concrete are:

a) IS 13311 (Part 1): 1992 – Methods of non-destructive testing of concrete Part 1 Ultrasonic Pulse velocity method
b) IS 13311 (Part 2): 1992 – Methods of non-destructive testing of concrete Part 2 Rebound hammer test method

Bricks

Bricks are the building block of any building or structure. They are manufactured from earthen clay. It is one of the cheapest building material used in the construction industry. Bricks are manufactured in the kilns. These are used to build walls, pavements and other masonry construction.

Normally, bricks contain the following ingredients:

1. Silica (sand) – 50% to 60% by weight
2. Alumina (clay) – 20% to 30% by weight
3. Lime – 2 to 5% by weight
4. Iron oxide – ≤ 7% by weight
5. Magnesia – less than 1% by weight

Indian Standards regarding various tests performed on bricks are tabulated below:

Sl No.	IS Code	Title
1	IS 3495 (Parts 1):2019	Burnt clay building bricks — Methods of tests: Part 1 Determination of compressive strength (*fourth revision*)
2	IS 3495 (Parts 2):2019	Burnt clay building bricks — Methods of tests: Part 2 Determination of water absorption (*fourth revision*)
3	IS 3495 (Parts 3):2019	Burnt clay building bricks — Methods of tests: Part 3 Determination of efflorescence (*fourth revision*)
4	IS 3495 (Parts 4):2019	Burnt clay building bricks — Methods of tests: Part 4 Determination of warpage (*fourth revision*)
5	IS 3495 (Parts 5):2021	Burnt clay building bricks — Methods of test: Part 5 Determination of initial rate of absorption

In India, bricks are manufactured in Bull's trench kilns. Manufacturing of bricks involves the following steps:

1. Preparation of earthen clay
2. Moulding of clay – can be hand moulded or machine moulded
3. Drying of raw bricks
4. Burning of bricks

Different types of bricks used in the construction industry are:

a) Paving bricks
b) Hollow bricks
c) Refractory bricks
d) Autoclaved bricks
e) Sand lime bricks
f) Light weight bricks
g) Heavy duty bricks

Sl No.	IS Code	Title
1	IS 1077:1992	Common burnt clay building bricks — Specification (*fifth revision*)
2	IS 2180:1988	Specification for heavy duty burnt clay building bricks (*third revision*)

3	IS 2222:1991	Specification for burnt clay perforated building bricks (*fourth revision*)
4	IS 2691:2017	Burnt clay facing bricks — Specification (*third revision*)
5	IS 3583:1988 IS 3583:1988 (B) IS 3583:1988 (H)	Specification for burnt clay paving bricks (*second revision*)
6	IS 3952:2013	Specification for burnt clay hollow bricks and blocks for walls and partitions (*third revision*)
7	IS 4885:1988	Specification for sewer bricks (*first revision*)
8	IS 5779:1986	Specification for burnt clay soling bricks (*first revision*)
9	IS 13757:1993	Specification for burnt clay fly ash building bricks

Reinforcing and Prestressing Steel

The reinforcement bars (or rebars) are provided to impart ductility in concrete structures along with increasing its tensile strength. It comes in the form of bars (or rods) and wires. It is widely used in buildings, skyscrapers, bridges, warehouses, foundations etc.

Steel is mainly used in two forms:

a) **Reinforcing steel:** This is mainly used in reinforced concrete elements like beams, columns, slabs, foundations etc. It is available in two forms – mild steel and HYSD bars. Example: Fe 250, Fe 415, Fe 500, Fe 550 etc.

b) **Prestressing Steel:** This is mainly used in prestressed or precast concrete structures like bridges, railway sleepers, electric poles etc. This type of steel generally comes in the form of cables, tendons or strands. This has a high value of tensile strength in the range of 800 – 1200 MPa due to large amount of losses in pretensioning/ post-tensioning methods.

Indian Standards on reinforcing steel are listed below:

Sl No.	IS Code	Title
1	IS 432 (Part 1):1982	Specification for mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement: Part 1 Mild steel and medium tensile steel bars (*third revision*)
2	IS 432 (Part 2):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*)
3	IS 1566:1982	Specification for hard-drawn steel wire fabric for concrete reinforcement (*second revision*)
4	IS 1786:2008	High strength deformed steel bars and wires for concrete reinforcement — Specification (*fourth revision*) (superseding IS 1139:1966)
5	IS 16651:2017	High strength deformed stainless steel bars and wires for concrete reinforcement — Specification

Indian Standards on prestressing steel are list below:

Sl No.	IS Code	Title
1	IS 1785 (Part 1):1983	Specification for plain hard-drawn steel wire for prestressed concrete: Part 1 Cold-drawn stress relieved wire (*second revision*)
2	IS 1785 (Part 2):1983	Specification for plain hard-drawn steel wire for prestressed concrete: Part 2 As-drawn wire (*first revision*)
3	IS 2090:1983	Specification for high tensile steel bars used in prestressed concrete (*first revision*)
4	IS 6003:2010	Indented wire for prestressed concrete — Specification
5	IS 6006:2014	Uncoated stress relieved strand for prestressed concrete — Specification (*second revision*)
6	IS 16644:2018	Stress-relieved low relaxation steel wire for prestressed concrete — Specification
7	*IS 14268:2017	Uncoated stress relieved low relaxation seven wire (ply) strand for prestressed concrete — Specification (*first revision*)

Following standards relates to structural steel:

- **IS 811: 1987** – Specification for cold formed structural steel sections (*second revision*)
- **IS 2062: 2011** – Hot rolled medium and high tensile structural steel (*seventh revision*)

All the above mentioned standards on mild steel, HYSD steel and prestressed steel give details about the manufacturing, physical and chemical composition of the rebars, and test requirements of the bars.

BIS has also formulated Special Publications for classification and details regarding steel sections used in the industry as listed below:

- SP (Part 1): 1964 – Structural steel sections
- SP (Part 2): 1962 – Steel beams and plate girders
- SP (Part 3): 1962 – Steel columns and struts
- SP (Part 7): 1972 – Simple welded girders

Steel bars are manufactured in the plant in standard sizes and length. For increasing the length of the rebars, either welding or mechanical couplers are used.

- **IS 16172: 2014** – Reinforcement couplers for mechanical splices of bars in concrete – Specification
- **IS 9417: 2018** – Welding of high strength steel bars for reinforced concrete construction – Recommendations (*second revision*)

Various mechanical properties of reinforcement steel are:

1. Physical properties which includes Ultimate tensile strength, yield strength, percentage elongation, 0.2 percent proof stress (in case of HYSD bar), UTS/YS ratio.
2. Tensile tests
3. Bend/ Rebend test
4. Chemical composition test
5. Free from Defects

Provisions for mechanical properties of wires and bars are given in IS 432 Part 1 and 2 respectively; for HYSD bars are given in IS 1786.

The mechanical properties of prestressing steel includes:

1. Physical properties which include breaking strength, elongation after fracture, relaxation, ductility and proof stress.
2. Tensile test
3. Reverse bend test
4. Chemical composition

Provisions for mechanical properties of wires and strands are given in IS 6003 and IS 14268 respectively.

Timber and Plywood

Timber is a finished wood product which is obtained from deciduous trees and used for building houses, furniture products etc.

IS 399: 1963 deals with classification of timber based on different purposes such as:

a) Constructional purposes, including building construction, house-posts, beams, rafters, cart-building, bridges, piles, poles and railway sleepers.
b) Furniture land cabinet making.
c) Light packing cases.
d) Heavy packing cases (for machinery and similar stores)
e) Agricultural implements and tool handles.
f) Turnery articles and toys.
g) Veneers and plywood.

Seasoning of timber is a process of reducing the moisture content in timber to a desired level. A well seasoned timber has more strength, stiffness, elasticity and is more durable. It also prevent it from the attack of insects and rodents. IS 1141: 1993 deals with seasoning of timber.

Preservation of timber is a method of reducing the deterioration and increasing the service life of timber. It prevents the timber from the attack of insects, worms, fungi, rodents etc. IS 401: 2001 deals with preservation of timber.

Different types of preservatives used for timber are as follows:

a) Oil type
b) Organic solvent type
c) Water soluble type
d) Water soluble (Leachable type)
e) Water soluble (Fixed type)

The standards dealing with preservation and types of preservatives are listed below:

Sl. No.	IS No.	Title
1	IS 401:2001	Preservation of timber — Code of practice (*fourth revision*)
2	IS 10013 (Part 1):1981	Specification for water soluble type wood preservatives: Part 1 Acid-copper-chrome (ACC) preservative
3	IS 10013 (Part 2):1981	Specification for water soluble type wood preservatives: Part 2 Copper-chrome-arsenic (CCA) wood preservative
4	IS 10013 (Part 3):1981	Specification for water soluble type wood preservatives: Part 3 Copper-chrome-boron (CCB) wood preservative
5	IS 10753:1983	Code of practice for preservation of wooden sleepers for railway track by pressure treatment
6	IS 9096:2006	Preservation of bamboo for structural purposes — Code of practice (*first revision*)

Various standards on timber panel products are:

Sl. No.	IS No.	Title
1	IS 190:1991	Coniferous sawn timber (Baulks and scantlings) — Specification (*fourth revision*)
2	IS 883:2016	Design of structural timber in building — Code of practice (*fifth revision*)
3	IS 1003 (Part 1):2003	Timber panelled and glazed shutters — Specification: Part 1 Door shutters (*fourth revision*)
4	IS 1003 (Part 2):1994	Timber panelled and glazed shutters — Specification: Part 2 Window and

		ventilator shutters (*third revision*)
5	IS 1326:1992	Non-coniferous sawn timber (Baulks and scantling) — Specification (*second revision*)
6	IS 2674:1988	Specification for battened plywood cases (*second revision*)
7	IS 7344:1974	Specification for bamboo tent poles
8	IS 10394:1982	Specification for wooden sleepers for railway track
9	IS 13622:1993	Indian timbers for furniture and cabinets — Classification
10	IS 16171:2014	Veneer laminated lumber — Specification
11	IS 15476:2004	Bamboo mat corrugated sheets — Specification
12	IS 14588:1999	Specification for bamboo mat veneer composites for general purposes
13	IS 13958:1994	Bamboo mat board for general purposes — Specification
14	IS 4021:1995	Specification for timber door, window and ventilator frames (*third revision*)

Stones

Stones are obtained from rocks which forms part of the earth's crust and composed of two or more minerals. These are used in building construction works such as foundation of structures, stone masonry, coarse aggregates for concrete mix etc.

Indian Standards providing specifications for various types of stones are as follows:

Sl. No.	IS No.	Title
1	IS 1128:1974	Specification for limestone (slab and tiles) (*first revision*)
2	IS 1130:1969	Specification for marble (blocks, slabs and tiles)
3	IS 3316:1974	Specification for structural granite (*first revision*)
4	IS 3620:1979	Specification for laterite stone block for masonry (*first revision*)
5	IS 3622:1977	Specification for sandstone (slabs and tiles) (*first revision*)
6	IS 6250:1981	Specification for roofing slate tiles (*first revision*)
7	IS 6579:1981	Specification for coarse aggregate for water bound macadam (*first revision*)
8	IS 9394:1979	Specification for stone lintels
9	IS 14223 (Part 1):1995	Polished building stones — Specification: Part 1 Granite

Following tests are performed on stones for testing their quality and strength:

a) Compressive strength
b) Tensile strength
c) Transverse strength
d) Shear strength
e) True specific gravity
f) Water absorption and porosity
g) Weathering
h) Durability
i) Abrasion resistance
j) Water transmission rate by capillary action
k) Surface softening by exposure to acidic atmospheres
l) Permeability
m) Toughness

Glass

Glass is a solid material formed by rapid cooling of molten silica (sand). It is a transparent, hard, brittle and impervious material. It is widely used for aesthetic or decorative looks like in building construction, housewares and telecommunications.

IS 16231 deals with the use of glass in buildings. Its various parts are:

- Part 1: 2019 – General methodology for selection (*first revision*)
- Part 2: 2019 – Energy and light (*first revision*)
- Part 3: 2019 – Fire and loading (*first revision*)
- Part 4: 2019 – Safety related to human impact (*first revision*)

Innovative Materials for use in building construction

1. Geosynthetics and Geopolymers

These are the synthetic materials which are mainly used in soil stabilization due to their high durability. They have a large number of civil engineering applications such as roads, embankments, dams, retaining walls, canals, reservoirs etc.

Indian Standards dealing with geosynthetics and geopolymers are listed below:

Sl. No.	IS Code	Title
1.	IS 17369	Geotextiles and geotextile related products – Strength of internal structural junctions
2.	(Part 1) : 2020	Geocomposites
3.	(Part 2) : 2020	Geocells
4.	IS 14716 : 1999	Geotextiles – Determination of mass per unit area
5.	IS 14714 : 1999	Geotextiles – Determination of abrasion resistance
6.	IS 14706 : 1999	Geotextiles – Sampling and preparation of test specimens
7.	IS 14293 : 1995	Geotextiles – Method of test for trapezoid tearing strength

2. Polymer based composite materials

IS 15643: 2006 deals with Non-destructive examination of polymer based composite materials – Code of practice

3. Fiber Reinforced Composites

These are the composite materials reinforced with fibers of synthetic or natural materials. They offer not only high strength to weight ratio but also exhibit exceptional properties such as high durability, stiffness, damping property, flexural strength, resistance to corrosion, wear, impact and fire etc. Due to these diverse features, FRCs has find wide range of applications in construction, automation, mechanical, aerospace, biomedical, marine and many other industries.

Fiber reinforced concrete and fiber based cement are the recent advancements in the concrete technology which possess lot of advantages over the conventional concrete.

- **IS 14862: 2000** – Fibre cement flat sheets – Specification
- **IS 14871: 2000** – Products in fibre reinforced cement – long corrugated or asymmetrical section sheets and fittings for roofing and cladding – Specification
- **IS 17161**: **2020** – Flexural strength and toughness parameters of fibre reinforced concrete – Method of test

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