THE REPUBLIC OF THE UNION OF MYANMAR

MINISTRY OF CONSTRUCTION

MYANMAR NATIONAL BUILDING CODE 2025

PART 6 - BUILDING MATERIALS

PART 7 - CONSTRUCTION MANAGEMENT AND PLANNING, CONSTRUCTION PRACTICES, SAFETY AND BUILDING MAINTENANCE

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JUNE, 2025

MINISTRY OF CONSTRUCTION
FOREWORD

In 2008, Cyclone Nargis, which hit Myanmar, caused extensive damage and necessitated the development of a Building Code to ensure the safety of buildings. The Ministry of Construction formed Technical Working Groups, in collaboration with United Nations Human Settlements Programme (UN-Habitat), the Myanmar Engineering Society, the Association of Myanmar Architects, related ministries, technological universities, and government organizations to develop the Myanmar National Building Code - 2012 (Provisional) (English Version) and distributed it to government departments and organizations.

In 2016, comments and advices sent from government departments and organizations were further incorporated and the directive was issued to follow Myanmar National Building Code - 2016 (English Version) in carrying out construction activities.

In 2020, the Technical Working Groups revised and modified the Building Code in accordance with the updated international standards. The Ministry of Construction distributed Myanmar National Building Code - 2020 [English and Myanmar Version] to the Union-level organizations, Union Ministries, Region and State governments and relevant organization to refer and follow them, and further issued the directive to the Myanmar Engineering Council, the Myanmar Architectural Council and the High-Rise and Public Building Projects Committee to follow them starting from 1st November, 2020.

In order to publish the Myanmar National Building Code (Updated Version) in line with the improved international standards, the Ministry of Construction has formed the Myanmar National Building Code Implementation Steering Committee, Implementation Working Committee, Drafting Sub-committee and Technical Working Groups (TWGs) in 2024. The publication of the Myanmar National Building Code – 2025 was made possible by joint efforts of the Ministry of Construction, the Ministry of Science and Technology and other related ministries, the Myanmar Engineering Council, the Myanmar Architect Council, the High-Rise and Public Building Projects Committee, the Federation of Myanmar Engineering Societies and its partner organizations, namely the Myanmar Earthquake Committee, the Myanmar Society of Civil Engineers, the Myanmar Society of Mechanical Engineers, the Myanmar Society of Welding Engineering, the Myanmar Green Building Society, the Myanmar International Consulting Engineers Group and the Environmental Conservation Consulting Engineers Association.

Following the Mandalay earthquake struck on 28th March, 2025, the Myanmar Earthquake Committee and the Myanmar Geoscience Association have undertaken the necessary preparations to build earthquake-resistant buildings.

Therefore, the Ministry of Construction acknowledged the contributions of the Ministries, the Myanmar Engineering Council, the Myanmar Architect Council, the High-rise and Public Building Projects Committee, the Federation of Myanmar Engineering Societies and partner organizations, the Myanmar Earthquake Committee, the Myanmar Geoscience Association and to those who have provided advice and assistance from various sectors to develop and publish the Myanmar National Building Code - 2025.

Ministry of Construction

MYANMAR NATIONAL BUILDING CODE 2025

PART 6

BUILDING MATERIALS

MYANMAR NATIONAL BUILDING CODE - 2025

PART 6: BUILDING MATERIALS

C O N T E N T S

MYANMAR NATIONAL BUILDING CODE – 2025
PART 6: BUILDING MATERIALS

6.1 SCOPE

This Part of the Code covers the requirements of building materials and components as well as the criteria for accepting new or alternative building materials and components.

6.2 MATERIALS

Every material used in fulfilling the requirements of this Part, unless otherwise specified in the Code or Duly Approved, shall conform to the relevant Myanmar Standards MMS, American Standard of Testing Materials (ASTM), Indian Standard (IS), International Standard Organization (ISO), American Welding Society (AWS), American Society of Mechanical Engineers (ASME), American Water Works Association (AWWA), American National Standards Institute (ANSI), Cast Iron Soil Pipe Institute (CISPI), Canadian Standards Association (CSA), International Association of Plumbing and Mechanical Officials (IAPMO), Japanese Industrial Standards (JIS), Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), National Fire Protection Association (NFPA), National Sanitation Foundation (NSF) or American Association of State Highway and Transportation Officials (AASHTO). A list of the "accepted standards" is given at the end of this Part of Code.

Remark:

- Building Materials included in this Myanmar National Building Code, MNBC 2025 refer to the MMS, ASTM, IS, ISO, AWS, ASME, AWWA, ANSI, CISPI, CSA, IAPMO, JIS, MSS, NFPA, NSF and AASHTO Standard.
- Ministry of Construction and Ministry of Science and Technology are collaborating on the development of the Myanmar Standards (MMS) for Building materials. Some of these are already being finalized and others are still under development.
- The completed MMS standards and specifications are added to this MNBC 2025 version.
- Until the National Level Standards and Specifications are fully established, all Building Materials should conform to the relevant MMS, ASTM, IS, ISO, AWS, ASME, AWWA, ANSI, CISPI, CSA, IAPMO, JIS, MSS, NFPA, NSF or AASHTO standards.
- In cases of overlapping between one standard and another, the MMS shall take precedence if it exists. If applicable MMS standard is not fully available, the ASTM, IS, ISO, AWS, ASME, AWWA, ANSI, CISPI, CSA, IAPMO, JIS, MSS, NFPA, NSF ASTM, AWS, ASME, AWWA, CISPI, CSA, IAPMO, MSS, NSF, IS, or AASHTO standards should be followed, in that order of priority.

6.3 NEW (OR) ALTERNATIVE MATERIALS

6.3.1 The provisions of this Part are not intended to prevent the use of any material not specifically prescribed under 6.2. Any such material may require the approval of the Concerned Authority or a Committee appointed by the Authority, provided it is well

established that the material is satisfactorily acceptable for the intended purpose. The Authority or the Committee concerned shall take into account the following parameters, with respect to the use of new or alternative building materials.

The prerequisite of the specified material shall comply with all relevant national standards on its usage and shall be evaluated for suitability in different geo-climatic conditions.

a) General appearance;

b) Dimension and dimensional stability;

c) Structural stability including strength properties;

d) Fire resistant;

e) Durability;

f) Thermal properties;

g) Mechanical properties;

h) Acoustical properties;

i) Optical properties;

j) Biological effect;

k) Environmental aspects;

l) Working condition;

m) Ease of handling; and

n) Consistency and workability.

For establishing the performance of the Material/component, laboratory/field tests and field trials are required. The study of historical data is also recommended.

6.3.2 Written approval from the Authority or the Concerned Committee appointed for evaluating the material's approval shall be obtained by the owner of the material or owner's representative before any new, alternative, or equivalent material is used. The Authority or The Committee appointed by them shall base such approval on the principle set in paragraph 6.3.1 and shall require that tests made (*see 7.1*) or sufficient evidence or proof be submitted. All expenses incurred shall be duly borne by the owner or owner's representative.

6.4 STORAGE OF MATERIALS

All building materials shall be stored on the construction site with all the necessary measures taken to prevent deterioration, the loss or impairment of their structural or other essential properties. (*See Part -7 Construction Practices, Safety and Building Maintenance*)

6.5 METHODS OF TEST AND MATERIAL SPECIFICATIONS

6.5.1 Every test of material required in this Part or by the Authority shall be carried out in accordance with the Myanmar Standards MMS, ASTM Standards, ISO, AWS, ASME, AWWA, ANSI, CISPI, CSA, IAPMO, JIS, MSS, NFPA, NSF ASTM, AWS, ASME, AWWA, CISPI, CSA, IAPMO, MSS, NSF, Indian Standards or AASHTO method of test. In case where

testing facilities or methods of tests for either the MMS, ASTM, ISO, AWS, ASME, AWWA, ANSI, CISPI, CSA, IAPMO, JIS, MSS, NFPA, NSF ASTM, AWS, ASME, AWWA, CISPI, CSA, IAPMO, MSS, NSF, IS or AASHTO are not available, the same shall conform to the methods of tests approved by the Authority. Laboratory tests shall be conducted by recognized laboratories acceptable to the Authority.

6.5.2 The manufacturer/supplier shall duly testify that materials conform to the requirements of the specifications and if requested shall produce a certificate to this effect either to the purchaser or his/her representative. When such test certificate is not available, the specimen of the material shall be subjected to all the required tests.

Followings are the Myanmar National Building Code Standards for various building materials and components, to be complied with in fulfilment of the requirements of the Code. The list has been arranged in order as follows:

(1) Aluminium and Other Light Metals and Their Alloys
(2) Bitumen and Tar Products
(3) Builder's Hardware
(4) Building chemicals
(5) Blocks, Bricks, Tiles and Masonry
(6) Cement and Concrete
(7) Doors, Windows and Ventilators
(8) Electrical Wiring, Fittings and Accessories
(9) Floor Covering, Roofing and Other Finishes
(10) Glass and Glazing
(11) Gypsum Board and Plaster
(12) Paints and Allied Products
(13) Polymers, Plastic and Geosynthetics/Geotextiles
(14) Material for Water Supply, Drainage and Sanitation
(15) Stones
(16) Structural Steel, Reinforcing Steel, Prestressing Steel and Others
(17) Thermal Insulation Materials
(18) Wood Based Materials
(19) Welding Electrodes and Wires
(20) Wire Ropes and Wire Products
(21) Road and Paving Materials
(22) Smart Cities

6.5.2.1. Aluminium and Other Light Metal and Their Alloy

Std: / Spec: No.	Title
ASTM B 209-14	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221-12e1	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bar, Rod, Wire, Profiles, and Tubes

ASTM B 308/B 308 M-10	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
ASTM B 313/B 313 M-09	Standard Specification for Aluminum and Aluminum-Alloy Round Welded Tubes
ASTM B 361-08	Standard Specification for Factory-Made Wrought Aluminum and Aluminum-Alloy Welding Fittings
ASTM B 429	Specification for Aluminum and Aluminum-Alloy Extruded Round Tubes for General-Purpose Applications
ASTM B 491	Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
ASTM B 557	Standard Test Method for Tension Testing Wrought and Cast Aluminum and Magnesium-Alloy Products
ASTM E 34	Test Method for Chemical Analysis of Aluminum and Aluminum-Base Alloys
ASTM F468	Specification for Nonferrous Bolts, Hex Cap Screws, and Studs
ASTM F1667	Specification for Driven Fasteners, Nails, Spikes, and Staples
IS 1254	Specification for Corrugated Aluminum Sheet
IS 1284	Specification for Wrought Aluminum and Aluminum Alloys Bolt and Screw Stock for General Engineering Purposes

6.5.2.2. Bitumen and Tar Products

(a) Specifications

Std:/ Spec: No.	Title
ASTM D 450	Standard specification for coal-tar pitch used in roofing, damp proofing and waterproofing
ASTM D 490	Standard specification for road tar
MMS ASTM D946/D946-20	Standard specification for Penetration-Graded Asphalt Binder for Use in Pavement Construction
ASTM D 977	Standard specification for Emulsified Asphalt
ASTM D 2026	Standard specification for Cutback asphalt (Slow-Curing type)
ASTM D 2027	Standard specification for Cutback asphalt (Medium-Curing type)
ASTM D 2028	Standard specification for Cutback asphalt (Rapid-Curing type)
ASTM D 2397	Standard specification for Cationic Emulsified Asphalt
IS 73	Specification for paving bitumen
IS 218	Specification for creosote oil for use as wood preservatives
IS 454	Specification for cutback bitumen from waxy crude
IS 702	Specification for industrial bitumen
IS 15462	Specification for polymer and rubber modified bitumen

(b) Methods for testing tar and bituminous materials

Std:/Spec No.	Title
ASTM D 4	Standard test method for bitumen content
MMS ASTM D5/D5M-19a	Standard test method for penetration for bituminous materials
MMS ASTM D 6/D 6M-95 (2018)	Standard test method for loss on heating of oil and

	asphaltic compounds
ASTM D 20	Standard test method for distillation of road tars
MMS ASTM D36/D36 M-14	Standard test method for softening point of bitumen (Ring-and-ball apparatus)
MMS ASTM D 70-18	Standard test method for density of semi-solid bituminous materials (Pycnometer Method)
MMS ASTM D 92-18	Standard test method for flash and fire points by Cleveland Open Cup tester
ASTM D 95	Standard test method for water in petroleum products and bituminous materials by distillation
MMS ASTM D 113-17	Standard test method for ductility of bituminous materials
ASTM D 139	Standard test method for float test for bituminous materials
ASTM D 140	Standard practice for sampling of bituminous materials
ASTM D 243	Standard test method for residue of specified penetration
ASTM D 244	Standard Test Methods and Practices for Emulsified Asphalts
ASTM D 402	Standard Test Method for Distillation of Cut-Back Asphaltic (Bituminous) Products
ASTM D 1188	Standard test method for bulk specific gravity and density of compacted bituminous mixtures using coated samples
ASTM D 1754	Standard test method for effects of heat and air on Asphaltic Materials (Thin-Film Oven test
MMS ASTM D 2042-15	Standard test method for solubility of asphalt materials in trichloroethylene
ASTM D 3205	Standard test method for viscosity of asphalt with cone and plate viscometer
IS 1207	Determination of equiviscous temperature
IS 9381	Determination of FRAASS breaking point of bitumen
IS 10512	Determination of wax content in bitumen
IS 15172	Determination of curing index for cutback bitumen
IS 15173	Determination of breaking point for cationic bitumen emulsion

6.5.2.3. Builder's Hardware

Terminology and Nomenclature

Std:/Spec No.	**Title**
ASTM A 90	Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 394	Standard Specification for Steel Transmission Tower Bolts, Zinc-Coated and Bare
IS 205	Specification for Steel Windows Stays and Fasteners
IS 206	Specification for Steel Gate Hooks
IS 208	Specifications for Mild Steel Hinges
IS 281	Specification for Mild Steel Sliding Door Bolts for Use with Padlock
IS 362	Specification for Parliament Hinges

IS 363	Specification for Hasps and Staples
IS 364	Specification for Fanlight Catch
IS 452	Specification for Door Springs, Rattail Type
IS 453	Specification for Double Acting Spring Hinges
IS 729	Specification for Drawer Locks, Cupboard Locks and Box Locks
IS 1341	Specification for Steel Butt Hinges
IS 1823	Specification for Floor Door Stoppers
IS 2209	Specification for Mortice Locks (Vertical Type)
IS 2681	Specification for Non-Ferrous Metal Sliding Door Bolts for Use with Padlock
IS 3564	Specification for Door Closers (Hydraulically Regulated)
IS 3818	Specification for Continuous (Piano) Hinges
IS 3828	Specification for Ventilator Chains
IS 4621	Specification for Indicating Bolts for Use in Public Baths and Lavatories
IS 4992	Specification for Door Handles for Mortice Locks (Vertical Type)
IS 5187	Specification for Flush Bolts
IS 5899	Specification for Bathroom Latches
IS 6318	Specification for Plastic Window Stays and Fasteners
IS 7534	Specification for Sliding Locking Bolts for Use with Padlock
IS 9106	Specification for Rising Butt Hinges
IS 9131	Specification for Rim Locks
IS 9460	Specification for Flush Drop Handles for Drawers
IS 9899	Specification for Hat, Coat and Wardrobe Hooks
IS 10019	Specification for Mild Steel Stays and Fasteners
IS 10342	Specification for Curtain Rail System
IS 12817	Specification for Stainless Steel Butt Hinges
IS 12867	Specification for PVC Handrail Covers

6.5.2.4. Building Chemical

(a) Chemical and Mineral Admixtures

Std:/Spec: No.	Title
ASTM C 233/C 233M	Standard Test method for air-entraining admixtures for concrete
ASTM C 260	Standard Specification for air-entraining admixtures for concrete
ASTM C 494/C 494 M	Standard Specification for chemical admixtures for concrete
ASTM C 618	Standard Specification for coal fly ash and raw or calcined natural pozzolan for use in concrete
ASTM C 989 /C 989 M	Standard Specification for slag cement for use in concrete and mortars.
ASTM C 1017 /C 1017M	Standard Specification for chemical admixtures for use in producing flowing concrete.
ASTM C 1240	Standard Specification for silica fume used in cement mixtures
ASTM A820/A820M	Standard Specification for Steel Fibers for Fiber-Reinforced Concrete

(b) Special Concrete Production Materials

Std:/Spec: No.	Title
ASTM C 330/C 330M	Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C 331/C331M	Standard Specification for Lightweight Aggregates for Concrete Masonry Units
ASTM C 332	Standard Specification for Lightweight Aggregates for Insulating Concrete
ASTM C 869 /C869M	Standard Specification for Foaming Agents Used in Making Preformed foam for Cellular Concrete
ASTM C 979/C979M	Standard Specification for pigments for integrally coloured concrete
ASTM C 1107/C1107M	Standard Specification for packaged dry, hydraulic-cement grout (Non-Shrink)
ASTM C1116/C1116M	Standard Specification for Fiber-Reinforced Concrete

(c) Concrete Curing Materials

Std:/Spec: No.	Title
ASTM C 171	Standard Specifications for sheet materials for curing concrete
ASTM C 309	Standard Specification for liquid membrane-forming compounds for curing concrete
ASTM C 1315	Standard Specification for liquid membrane-forming compounds having special properties for curing and sealing concrete

(d) Waterproofing and Damp-proofing Materials

Std:/Spec: No.	Title
ASTM D 41 /D41M	Standard Specification for asphalt primer used in roofing, damp proofing and waterproofing
ASTM D 43/D43M	Standard Specification for coal tar primer used in roofing, damp proofing and waterproofing
ASTM D 173/D173M	Standard Specification for bitumen-saturated cotton fabrics used in roofing and waterproofing
ASTM D 449/ D 449M	Standard Specification for asphalt used in damp proofing and waterproofing
ASTM D 450/D 450M	Standard Specification for coal-tar pitch used in roofing, damp proofing and waterproofing
ASTM D1327 / D1327M	Standard Specification for bitumen-saturated woven burlap fabrics used in roofing and waterproofing
ASTM D 1668/ D1668M	Standard Specification for glass fabrics (woven and treated) for roofing and waterproofing

(e) Epoxy Compound Materials

Std:/Spec: No.	Title
ASTM C 881 / C881M	Standard Specification for epoxy-resin-base bonding systems for concrete

ASTM C 884 / C 884M	Standard Test method for thermal compatibility between concrete and an epoxy- resin overlay

6.5.2.5. Blocks, Bricks, Tiles and Masonry

Std:/Spec: No.	Title
ASTM C32-13(2017)	Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 55 -14a	Standard Specification for Concrete Building Brick
ASTM C 62-17	Standard specification for building brick (solid masonry units made from clay or shale)
ASTM C 67/C67M-23	Standard test methods for sampling and testing brick and structural clay tile
ASTM C 140/C140M-15	Standard test methods for sampling and testing concrete masonry units and related units
ASTM C 216-15	Standard specifications for facing brick (Solid masonry units made from clay or shale)
ASTM C279-23	Standard Specification for Chemical-Resistant Masonry Units
ASTM C410-13(2017)	Standard Specification for Industrial Floor Brick
ASTM C 652-15	Standard specification for hollow brick (hollow masonry units made from clay or shale)
ASTM C 902-14	Standard specification for pedestrian and light traffic paving brick
ASTM C1088-20	Standard Specification for Thin Veneer Brick Units Made from Clay or Shale
ASTM C 1196-14a	Standard test method for in situ compressive stress within solid unit masonry estimated using flat jack measurements
ASTM C 1232-15a	Standard Terminology of masonry
ASTM C1261-13(2017) e1	Standard Specification for Firebox Brick for Residential Fireplaces
ASTM C 1272-14a	Standard specification for heavy vehicular paving brick
ASTM C1405-15	Standard Specification for Glazed Brick (Single Fired, Brick Units)
ASTM C1634-15	Specification of concrete facing bricks
IS 2117	Guide for manufacture of handmade common burnt clay building bricks
IS 2185	Standard Specification for Hollow and solid concrete blocks (Concrete masonry units)
IS 2222	Specification for burnt clay perforated building bricks
IS 3495	Method of test for burnt clay building bricks
IS 3583	Specification for common burnt clay paving bricks
IS 4885	Specification for sewer bricks
IS 5454	Method of sampling clay building bricks
IS 11650	Guide for manufacture of common burnt clay building bricks by semi mechanized process
IS 13757	Specification of burnt clay fly ash bricks

Remarks

Note:

(a) Where non-load bearing structures or structures which are not important (eg; non- load bearing wall, drain, fencings, etc.,) the use of bricks which do not meet the standard specification given in the MNBC may be utilized. However, the suitability of the bricks shall be duly endorsed by the authority concerned.

(b) Bricks used for structures other than those given in (a), i.e. Bricks used for load bearing structures, must duly meet the standard specified in MNBC.

6.5.2.6. Cement and Concrete

(a) Aggregates

Std:/Spec: No.	Title
ASTM C 29/ C 29 M	Standard test method for bulk density ("unit weight") and voids in aggregate
ASTM C 33/ C33M	Standard Specification for concrete aggregates
ASTM C 35	Standard Specification for inorganic aggregates for use in gypsum plaster
ASTM C 40	Standard test method for organic impurities in fine aggregates for concrete
ASTM C 66	Specification for sand for use in lime plaster
ASTM C 88 / C88M	Standard test method for soundness of aggregates by use of sodium sulfate or magnesium sulfate
ASTM C 127	Standard Test method for relative density (specific gravity), and absorption of coarse aggregate
ASTM C-131(2014)	Standard Test Method for Resistance to Degradation of small - Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 128	Standard Test method for relative density (specific gravity), and absorption of fine Aggregate
ASTM C 136	Standard test method for sieve analysis of fine and coarse aggregates
ASTM C142 (2017)	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C 144	Standard specification for aggregate for masonry mortar
ASTM C 294	Standard descriptive nomenclature for constituents of concrete aggregates
ASTM C 330	Standard specification for lightweight aggregates for structural concrete
ASTM C 1260	Standard test method for potential alkali reactivity of aggregates (mortar-bar method)
ASTM C 1293	Standard test method for determination of length change of concrete due to alkali-silica reaction
ASTM D 75 / D75 M	Standard Practice for sampling aggregates
BS 812-110(1990)	Testing Aggregate Part 110: Methods for determination of aggregate crushing value (ACV)

(b) Cement

Std:/Spec: No.	Title
ASTM C 91	Standard Specification for masonry cement
MMS ASTM C 150/C150M-18	Standard Specification for portland cement
ASTM C 195	Standard specification for mineral fiber thermal insulating cement
ASTM C 196	Standard specification for expanded or exfoliated vermiculite thermal insulating cement
ASTM C 595	Standard Specification for blended hydraulic cement
ASTM C 845	Standard Specification for expansive hydraulic cement
ASTM C 1157	Standard performance specification for hydraulic cement
MMS ASTM C204-18	Standard test method for fineness of hydraulic cement by air-permeability apparatus
MMS ASTM C191-18	Standard test method for time of setting of hydraulic cement by Vicat needle
MMS ASTM C151/C151M-18	Standard test method for autoclave Expansion of Hydraulic cement
IS 1489	Specification for portland pozzolana cement (calcined clay based)
IS 6452	Specification for high alumina cement for structural use
IS 8041	Specification for rapid hardening portland cement
IS 8042	Specification for white portland cement
IS 8043	Specification for hydrophobic portland cement
IS 12330	Specification for sulphate resisting portland cement
IS 12600	Specification for portland cement low heat
BS EN 196-3(2016)	Methods of testing cement Part 3: Determination of setting times and soundness

(c) Water

Std:/Spec: No.	Title
ASTM C 1602/C 1602 M	Standard specification for mixing water used in the production of hydraulic cement concrete
ASTM D 1294	Standard test methods for pH of water

(d) Pozzolans

Std:/Spec: No.	Title
ASTM C 311	Standard test methods for sampling and testing fly ash or natural pozzolans for use in Portland-cement concrete
ASTM C 618	Standard specification for coal fly ash and raw or calcined natural pozzolan for use in concrete
ASTM C 989/C989M	Standard specification for slag cement for use in concrete and mortars
ASTM C 1240	Standard Specification for silica fume used in cementitious mixtures
ASTM C 1709	Standard guide for evaluation of alternative supplementary cementitious materials (ASCM) for use in concrete

IS 12871	Calcined clay pozzolana Methods of sampling

(e) Concrete

Std:/Spec: No.	**Title**
ASTM C 94/C 94 M	Standard specification for ready mixed concrete
ASTM C 172 /C172M	Standard practice for sampling freshly mixed concrete
ASTM C 685 / C685M	Standard specification for concrete made by volumetric batching and continuous mixing
IS 1344	Code of practice for prestressed concrete

(f) Cement and Concrete Sampling and methods of test

Std:/Spec: No.	**Title**
ASTM C 31/C 31 M	Standard practice for making and curing concrete test specimens in the field
ASTM C 39/C 39 M	Standard Test method for compressive strength of cylindrical concrete specimens
ASTM C 42/C 42 M	Standard test method for obtaining and testing drilled cores and sawed beams of concrete
ASTM C 79	Standard test method for flexural strength of concrete (using simple beam with third-point loading)
MMS ASTM C109/C109M-16a	Standard test methods for compressive strength of hydraulic cement mortars (using 2-in or [50mm] cube specimens)
ASTM C 114	Standard Test methods for chemical analysis of hydraulic cement
ASTM C 115	Standard Test method for fineness of portland cement by the turbidimeter
ASTM C 143/C 143 M	Standard Test method for slump of hydraulic-cement concrete
ASTM C 151 / C151M	Standard test method for autoclave expansion of hydraulic cement
ASTM C 172 /C172M	Standard practice for sampling freshly mixed concrete
ASTM C 183	Standard practice for sampling and the amount of testing of hydraulic cement
ASTM C 185	Standard test method for air content of hydraulic cement mortar
ASTM C 186	Standard test method for heat of hydration of hydraulic cement
ASTM C 187	Standard test method for amount of water required for normal consistency of hydraulic cement
ASTM C 188	Standard test method for density of hydraulic cement
ASTM C 191	Standard test method for time of setting of hydraulic cement by Vicat needle
ASTM C 192/C 192 M	Standard practice for making and curing concrete test specimens in the laboratory
ASTM C 204	Standard test methods for fineness of hydraulic cement by air-permeability apparatus
ASTM C 232	Standard test methods for bleeding of concrete

ASTM C 293/293M	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading)
ASTM C 403 / C403M	Standard test method for time of setting of concrete mixtures by penetration resistance
ASTM C 451	Standard test method for early stiffening of hydraulic cement (paste method)
ASTM C 452	Standard test method for potential expansion of portlandcement mortars exposed to sulfate
ASTM C 496 / C496M	Standard test method for splitting tensile strength of cylindrical concrete specimens
ASTM C 512 / C512M	Standard test method for creep of concrete in compression
ASTM C 567 / C 567M	Standard test method for determining density of structural light weight concrete
ASTM C 597	Standard test method for ultrasonic pulse velocity through concrete
ASTM C 805 / C805M	Standard test method for rebounding number of hardened concretes
ASTM C 900	Standard test method for pullout strength of hardened concrete
ASTM C 944	Standard test method for abrasion resistance of concrete or mortar surfaces by the rotating-cutter method
ASTM C 1218/C 1218 M	Standard test method for water-soluble chloride in mortar and concrete
ASTM C-1231(2015)	Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Cylindrical Concrete Specimens
ASTM C 1314	Standard test method for compressive strength of masonry prisms
ASTM C 1583 / C 1583M	Standard test method for tensile strength of concrete surfaces and the bond strength or tensile strength of concrete repair and overlay materials by direct tension (pull-off method)
IS 517	Methods of test for strength of concrete
BS EN 12390-3 (2019: E)	Testing hardened concrete Part 3- Compressive strength of test Specimens

(g) Cement matrix products

Std:/Spec: No.	**Title**
ASTM C 62	Standard specification for building brick (solid masonry units made from clay or shale)
ASTM C 90	Standard specification for load bearing concrete masonry units
ASTM C 129	Standard Specification for non-load bearing concrete masonry units
ASTM C 145	Standard specification for solid load bearing concrete masonry units
ASTM C 157 / C 157M	Standard test method for length change of hardened hydraulic cement mortar and concrete
ASTM C 270	Standard specification for mortar for unit masonry

ASTM C 426	Standard test method for linear drying shrinkage of concrete
ASTM C 476	Standard specification for grout for masonry
ASTM C 1072	Standard Test Methods for Measurement of Masonry Flexural Bond Strength
ASTM E 518	Standard Test Methods for Flexural Bond Strength of Masonry
ASTM E 519	Standard Test Method for Diagonal Tension (Shear) in Masonry Assemblages

(h) Lime

Std:/Spec: No.	**Title**
ASTM C 5	Standard Specification for quicklime for structural purposes
ASTM C 25	Standard Test methods for chemical analysis of limestone, quicklime, and hydrated lime
ASTM C 50 / C50M	Standard practice for sampling, sample preparation, packaging, and marking of lime and limestone products
ASTM C 110	Standard test methods for physical testing of quicklime, hydrated lime, and limestone
ASTM C 141 /C141M	Standard specification for hydrated hydraulic lime for structural purposes
ASTM C 206	Standard specification for finishing hydrated lime
ASTM C 207	Standard specification for hydrated lime for masonry purposes

6.5.2.7. <u>Doors, Windows and Ventilators</u>

(a) Wooden doors, Windows and Ventilators

Std:/Spec: No.	**Title**
ASTM E 152	Methods for fire test of door assemblies
ASTM E 283-04 (2012)	Standard test method for determining the rate of air leakage through exterior windows, skylights, curtain walls, and doors under specified pressure and temperature differences across the specimen
ASTM E 330/E330M-14(2021)	Standard test method for structural performance of exterior windows, doors, skylights and curtain walls by uniform static air pressure difference
ASTM E 331-00 (2016)	Standard test method for water penetration of exterior windows, skylights, curtain walls, and doors by uniform static air pressure difference
ASTM E 547	Standard test method for water penetration of exterior windows, skylight, doors and curtain walls by cyclic static pressure
ASTM E 783	Standard test method for field measurement of air leakage through installed exterior windows and doors
ASTM E 1886	Standard test method for performance of exterior windows, curtain walls, doors, and storm shutters impacted by missile(s) and exposed to cyclic pressure differentials
ASTM E 1996	Standard specification for performance of exterior windows,

	glazed curtain walls, doors, and storm shutters impacted by windborne debris in hurricanes
ASTM E 2068	Test method for determination of operating force of sliding windows and doors
ASTM F 842	Standard test methods for measuring the forced entry resistance of sliding door assemblies, excluding glazing impact
IS 1003	Specification for timber panelled and glazed shutters
Part 1	Door shutters
Part 2	Window and ventilator shutters
IS 1141	Code of practice for seasoning of timber
IS 1826	Specification for venetian blinds for windows
IS 2191	Specification for wooden flush door shutters (cellular and hollow core type)
Part 1	Plywood face panels
Part 2	Particleboard face panels and hard board face panels
IS 2202	Specification for wooden flush door shutters (solid core type)
IS 4020	Method of test for door shutters
Part-1	General
Part-2	Measurement of dimensions and squareness
Part-3	Measurement of general flatness
Part-4	Local planeness test
Part-5	Impact indentation test
Part-6	Flexure test
Part-7	Edge loading test
Part-8	Shock resistance test
Part-9	Buckling resistance test
Part-10	Slamming test
Part-11	Misuse test
Part-12	Varying humidity test
Part-13	End immersion test
Part-14	Knife test
Part-15	Glue adhesion test
Part-16	Screw withdrawal resistance test
IS 4021	Specification for timber door, window and ventilator frames
IS 4913	Code of practice for selection, installation and maintenance of timber doors and windows
IS 4962	Specification for wooden side sliding doors
IS 6198	Specification for ledged, braced and battened timber shutters
IS 6523	Specification for precast reinforced concrete door, window frames

(b) Metal doors, windows frames and ventilators

Std:/Spec: No.	**Title**
IS 1038	Specification for steel doors, windows and ventilators
IS 1361	Specification for steel windows for industrial buildings
IS1948	Specification for aluminium doors, windows and ventilators

IS1949	Specification for aluminium windows for industrial buildings
IS 4351	Specification for steel door frames
IS 6248	Specification for metal rolling shutters and rolling grills
IS 7452	Specification for hot rolled steel sections for doors, windows and ventilators
IS 10451	Specification for steel sliding shutters
IS 10521	Specification for collapsible gates

(c) Plastic doors and windows

Std:/Spec: No.	**Title**
ASTM D 638	Standard test method for tensile properties of plastics
IS 14856	Specification for glass fibre reinforced (GRP) panel type door shutters for internal use
IS 15380	Specification for moulded raised high-density fibre (HDF) panel doors

6.5.2.8. Electrical Wiring, Fittings and Accessories

Std:/Spec: No.	**Title**
IS 371	Specification for ceiling roses
IS 374	Specification for electric ceiling type fans and regulators
IS 418	Specification for tungsten filament general service electric lamps
IS 1258	Specification for bayonet lamp holders
IS1293	Specification for plugs and socket outlets rated voltage up to and including 250 V and rated current up to and including 16 amperes
IS 1534	Specification for ballasts for fluorescent lamps:
Part 1	for switch start circuits
IS 1554	PVC insulated (heavy duty) electric cables:
Part 1	For working voltages up to and including 1100 V
Part 2	For working voltages from 3.3 kV up to and including 11 kV
IS 1777	Specification for industrial luminaire with metal reflectors
IS 1985	General purpose luminaires
Part 5/Sec 2	Particular requirements, Section 2
IS 1985	Recessed luminaires
Part 5/Sec 3	Particular requirements, Section 3
IS 1987	Luminaires for road and street lighting
Part 5/Sec 4	Particular requirements, Section 4
IS 1987	Portable general purpose luminaires
Part 5/Sec 5	Particular requirements, Section 5
IS 1987	Flood light
IS 2086	Specification for carriers and bases used in re-wirable type electric fuses up to 650 V
IS 2148	Specification for flameproof enclosures “d” for electrical

	apparatus for explosive gas atmospheres
IS 2206	Specification for flameproof electric lighting fittings
Part 1	Well glass and bulkhead types
Part 2	Fittings using glass tubes
Part 3	Fittings using fluorescent lamps and plastic covers
Part 4	Portable flame-proof handlamps and approved flexible cables
IS 2215	Specification for starters for fluorescent lamps
IS 2412	Specification for link clips for electrical wiring
IS 2418	Specification for tubular fluorescent lamps for general lighting services:
Part 1	Requirements and tests
Part 2	Standard lamp data sheets
Part 3	Dimensions of G-5 and G-13 bi-pin caps
Part 4	Go and no-go gauges for G-5 and G-13 bi-pin caps
IS 2667	Specification for fittings for rigid steel conduits for electrical wiring
IS 2675	Specification for enclosed distribution fuse boards and cut outs for voltages not exceeding 1000 V
IS 3287	Specification for industrial lighting fittings with plastic reflectors
IS 3323	Specification for bi-pin lamp holders for tubular fluorescent lamps
IS 3324	Specification for holders for starters for tubular fluorescent lamps
IS 3419	Specification for fittings for rigid non-metallic conduits
IS 3480	Specification for flexible steel conduits for electrical wiring
IS 3528	Specification for waterproof electric lighting fittings
IS 3553	Specification for watertight electric lighting fittings
IS 3837	Specification for accessories for rigid steel conduits for electrical wiring
IS 3854	Specification for switches for domestic and similar purposes
IS 4012	Specification for dust-proof electric lighting fittings
IS 4013	Specification for dust-tight electric lighting fittings
IS 4160	Specification for interlocking switch socket outlet
IS 4615	Specification for switch socket outlets (non-interlocking type)
IS 4649	Specification for adaptors for flexible steel conduits
IS 5077	Specification for decorative lighting outfits
IS 6538	Specification for three-pin plugs made of resilient material
IS 8030	Specification for luminaires for hospitals
IS 8828	Specification for circuit-breakers for over current protection for household and similar installation
IS 9537	Specification for conduits for electrical installations:
Part 1	General requirements
Part 2	Rigid steel conduits
Part 3	Rigid plain conduits for insulating materials
Part 4	Pliable self-recovering conduits for insulating materials

Part 5	Pliable conduits of insulating materials
Part 6	Pliable conduits of metal or composite materials
Part 8	Rigid non- threadable conduits of aluminium alloy
IS 9926	Specification for fuse wires used in re-wirable type electric fuses up to 650 V
IS 10322	Specification for luminaires
Part 1	General requirements
Part 2	Constructional requirements
Part 3	Screw and screw less terminations
Part 4	Methods of tests
Part 5	Particular requirements, Section 1
IS 11037	Electronic type fan regulators
IS 12640	Residual Current operated circuit-breakers for household and similar uses
IS 12640-Part 1	Circuit-Breakers without integral overcurrent protection (RCCBs)
MMS IEC 61008-1:2010	
MMS IEC 61008-1:2012 Amendment 1	
MMS IEC 61008-1:2013 Amendment 2	
IS 12640-Part 2	Circuit-Breakers with integral overcurrent protection (RCBOs)
MMS IEC 61009-1:2010+AMD1:2012+AMD2:2013	
IS 13010	AC watt-hour meters, Class 0.5, 1 and 2
IS 13779	AC static watt hour meters (Class 1 and 2)
IS 13947	Specification for low voltage
Part 3	Switch gear and control gear: Part 3 switches, disconnectors, switch disconnectors and fuse combination units
IS14763	Conduit for electrical purposes, outside diameters of conduits for electrical installations and threads for conduits and fittings
IS14768	Conduit fittings for electrical installations:
Part 1	General requirements
Part 2	Metal conduit fittings
IS 14772	Enclosures for accessories for household and similar fixed electrical installations
IS 14927	Cable trunking and ducting systems for electrical installations
Part 1	General requirements
Part 2	Cable trunking and ducting systems intended for mounting on walls or ceilings
IS 14930	Conduit systems for electrical installations:
Part 1	General requirements
Part 2	Particular requirements for conduit system buriedunderground
IS 15368	Cable reels for household and similar purposes

Remarks: Cables, wires and busbars to be used in buildings must have a valid certificate from a recognized laboratory of the relevant country of manufacture (or) a valid certificate from a recognized laboratory of Myanmar (or) a valid quality inspection certificate / Electrical Safety Certificate of domestically produced electrical equipment from the Electrical Inspection Department (Laboratory) that confirms that the cables, wires and busbars meet the standards of the relevant country of manufacture.

6.5.2.9. Floor Covering, Roofing and Other Finishes

(a) Flooring

Std:/Spec: No.	Title
ASTM F 710	Standard practice for preparing concrete floors to receive resilient flooring
IS 3670	Code of practice for construction of timber floors
IS 5766	Code of practice for laying burnt clay brick flooring
IS 13801	Specification for chequered cement concrete tiles

(b) Flooring compositions

Std:/Spec: No.	Title
ASTM F 1066	Specification for vinyl composition floor tile
IS 9162	Methods of tests for epoxy resins, hardness and epoxy resin compositions for floor topping
IS 9197	Specification for epoxy resin, hardness and epoxy resin compositions for floor topping

(c) Linoleum flooring

Std:/Spec: No.	Title
ASTM F 2034	Specification for sheet linoleum floor covering
ASTM F 2195	Specification for linoleum floor tile
IS 9704	Methods of tests for linoleum sheets and tiles

(d) Ceramic and other finishings

Std:/Spec: No.	Title
ASTM C 57	Specification for structural clay floor tile
ASTM C 212	Standard specification for structural clay facing tile
ASTM C 373	Determination of water absorption, bulk density, apparent porosity and apparent specific gravity of fired white ware products, ceramic tiles and glass tiles
ASTM C 424	Standard test method for crazing resistance of fired glazed white wares by autoclave treatment
ASTM C 484	Standard test method for thermal shock resistance glazed ceramic tile
ASTM C 648	Standard test method for breaking strength of ceramic tile
ASTM C 1026	Standard test method for measuring the resistance of ceramic and glass tile to freeze-thaw cycling
ASTM C 1027	Standard test method for determining visible abrasion resistance of glazed ceramic tile
IS 3951	Specification for hollow clay tiles for floors and roofs
ISO 10545-1:2014	Ceramic Tiles - Part 1: Sampling and basis for acceptance
ISO 10545-2:2018	Ceramic Tiles - Part 2: Determination of dimensions and surface quality
ISO 10545-3:2018	Ceramic Tiles - Part 3: Determination of water absorption,

	apparent porosity, apparent relative density and bulk density
ISO 10545-4:2019	Ceramic Tiles - Part 4: Determination of modulus of rupture and breaking strength
ISO 10545-5:1996	Ceramic Tiles - Part 5: Determination of impact resistance by measurement of coefficient of restitution
ISO 10545-6:2010	Ceramic Tiles - Part 6: Determination of resistance to deep abrasion for unglazed tiles
ISO 10545-7:1996	Ceramic Tiles - Part 7: Determination of resistance to surface abrasion for glazed tiles
ISO 10545-8:2014	Ceramic Tiles - Part 8: Determination of Linear thermal expansion
ISO 10545-9:2013	Ceramic Tiles - Part 9: Determination of resistance to thermal shock
ISO 10545-10:2021	Ceramic Tiles - Part 10: Determination of moisture expansion
ISO 10545-11:1994	Ceramic Tiles - Part 11: Determination of crazing resistance for glazed tiles
ISO 10545-12:1995	Ceramic Tiles - Part 12: Determination of Frost resistance
ISO 10545-13:2016	Ceramic Tiles - Part 13: Determination of chemical resistance
ISO 10545-14:2015	Ceramic Tiles - Part 14: Determination of resistance to stains
ISO 10545-15:2021	Ceramic Tiles - Part 15: Determination of lead and cadmium given off by tiles
ISO 10545-16:2010	Ceramic Tiles - Part 16: Determination of small colour differences
ISO 10545-18:2022	Ceramic Tiles - Part 18: Determination of light reflectance value (LRV)
ISO 10545-20:2022	Ceramic Tiles - Part 20: Determination of deflection of ceramic tiles for calculating their radius of curvature
ISO 13006:2018	Ceramic Tiles - Definitions, classification, characteristics and marking
ANSI A137.1	Standard Specification for Ceramic Tiles
ASTM C370- 12	Standard Test Method for Moisture Expansion of Fired Whiteware Products
ASTM C372-94(2012)	Standard Test Method for Linear Thermal Expansion of Porcelain Enamel and Glaze Frits and Fired Ceramic Whiteware Products by the Dilatometer Method
ASTM C373 -14a	Standard Test Method for water absorption, bulk density, apparent porosity and apparent specific gravity of Fired Whiteware products, Ceramic tiles and glass tiles
ASTM C424-93(2012)	Standard Test Method for Crazing Resistance of Fired Glazed Whitewares by Autoclave Treatment
ASTM C482-02(2014)	Standard Test Method for Bond Strength of Ceramic Tile to Portland Cement Paste
ASTM C484-99(2014)	Standard Test Method for Thermal Shock Resistance of Glazed Ceramic Tile
ASTM C485 -09	Standard Test Method for Measuring Warpage of Ceramic Tile
ASTM C499-09(2014)	Standard Test Method for Facial Dimensions and Thickness of

	Flat, Rectangular Ceramic Wall and Floor Tile
ASTM C502-09	Standard Test Method for Wedging of Flat, Rectangular Ceramic Wall and Floor Tile
ASTM C609-07(2014)	Standard Test Method for Measurement of Light Reflectance Value and Small Color Differences Between Pieces of Ceramic Tile
ASTM C648 -04(2014)	Standard Test Method for Breaking Strength of Ceramic Tile
ASTM C650-04(2014)	Standard Test Method for Resistance of Ceramic Tile to Chemical Substances
ASTM C1026-13	Standard Test Method for Measuring the Resistance of Ceramic and Glass Tile to Freeze-Thaw Cycling
ASTM C1027-09	Standard Test Method for Determining Visible Abrasion Resistance of Glazed Ceramic Tile
ASTM C1243-93(2015)	Standard Test Method for Relative Resistance to Deep Abrasive Wear of Unglazed Ceramic Tile by Rotating Disc
ASTM C1378 -04(2014)	Standard Test Method for Determination of Resistance to Staining
IS 13630	Method of test for ceramic tiles
IS 13630	Determination of moisture expansion using boiling water (unglazed tiles)
IS 13630	Determination of linear thermal expansion
IS 13630	Determination of modulus of rupture
IS 13630	Determination of chemical resistance (Glazed tiles)
IS 13630	Determination of chemical resistance (Unglazed tiles)
IS 13630	Determination of resistance to surface abrasion (Glazed tiles)
IS 13630	Determination of scratch hardness of surface according to "Mohs"
IS 13711	Sampling and basis for acceptance of ceramic tiles

(e) Roofing

Std:/Spec: No.	**Title**
ASTM C 1167	Specification for clay roofing tiles
ASTM C 1492	Specification for concrete roof tile
ASTM D 41	Specification for asphalt primer used in roofing, damp proofing waterproofing
ASTM D 312	Specification for asphalt used in roofing
ASTM D 2822	Specification for asphalt roof cement
ASTM D 3746	Test method for impact resistance of bituminous roofing systems
ASTM D 4434	Specification for poly (vinyl chloride) sheet roofing
ASTM E 108	Standard test methods for fire test of roof coverings BUILDING MATERIALS
IS 277	Specification for galvanized steel sheets (plain and corrugated)
IS 6250	Specification for roofing slate tiles
IS 1464	Specification for clay ridge and ceiling tiles
IS 2690	Specification for burnt clay flat terracing tiles

Part 1	Machine made
Part 2	Hand made
IS 12583	Specification for corrugated bitumen roofing sheets
IS 12866	Specification for plastic translucent sheets made from thermosetting polyester resin (glass fibre reinforced)

(f) Wall covering / finishing

Std:/Spec: No.	**Title**
ASTM C 34	Specification for structural clay load-bearing wall tile
ASTM C 52	Specification for gypsum partition tile or block
ASTM C 56	Specification for structural clay non-load bearing tile
ASTM C 126	Specification for ceramic glazed structural clay facing tile, facing brick, and solid masonry units
IS 15418	Specification for finished wall papers, wall vinyl and plastic wall coverings in roll form

6.5.2.10. Glass and Glazing

Std:/Spec: No.	**Title**
ASTM C 1036-11e1	Specification for flat glass
ASTM C 1172-14	Specification for laminated architectural flat glass
ASTM C 1369-07 (2014)	Specification for secondary edge sealants forstructurally glazed insulating glass units
ASTM C 1503-08 (2013)	Specification for silvered flat glass mirrors
ASTM E 773-01	Test method for accelerated weathering of sealed insulating glass units
ASTM E 774-97	Specification for classification of the durability of sealed insulating glass units
ASTM E 1300-12ae1	Standard practice for determining load resistance of glass in building
ASTM E 2188-10	Standard test method for insulating glass unit performance
ASTM E 2189-10e1	Standard test method for testing resistance to fogging in insulating glass units
ASTM F 1642-12	Standard test method for glazing and glazing systems subject to air blast loadings
IS 5437	Specification for figured rolled and wired glass
IS 14900	Specification for transparent float glass
MMS ISO 12540-2017	Glass in building — Tempered soda lime silicate safety glass
MMS ISO 12543 – 2-2021	Glass in building — Laminated glass and Laminated safety glass — Part 2: Laminated safety glass
MMS ISO 12543 - 4-2021	Glass in building — Laminated glass and Laminated safety glass — Part 4: Test method for durability

6.5.2.11. Gypsum Board and Plaster

Std:/Spec: No.	**Title**
ASTM C11	Standard Terminology Relating to Gypsum and Related Building Materials and Systems

ASTM C 22/C 22 M	Standard specification for gypsum
ASTM C 28/C 28 M	Standard specification for gypsum plasters
ASTM C 471	Standard Test Methods for Chemical Analysis of Gypsum and Gypsum Products (Metric)
ASTM C 473	Standard test Methods for physical testing of gypsum panel products
ASTM C 474	Standard Test Methods for Joint Treatment Materials for Gypsum Board Construction
ASTM C 557	Standard specification for adhesives for fastening gypsum wallboard to wood framing
ASTM C 587	Standard specification for gypsum veneer plaster
ASTM C 631	Standard specification for bonding compounds for interior gypsum plastering
ASTM C 840	Standard Specification for Application and Finishing of Gypsum Board
ASTM C 842	Standard Specification for Application of Interior Gypsum Plaster
ASTM C 1047	Standard specification for accessories of gypsum wall board and gypsum vaneer base
ASTM C 1177/ C 1177 M	Standard specification for glass mat gypsum substrate for use as sheathing
ASTM C 1178/ C 1178 M	Standard specification for glass coated mat water-resistant gypsum backing panel
ASTM C 1278/ C 1278 M	Standard specification for fiber-reinforced gypsum panels
ASTM C 1396/ C 1396 M	Standard specification for gypsum board

6.5.2.12. Paints and Allied Products

(a) Specifications for water-based paints and pigments

Std:/Spec: No.	Title
IS 427	Specification for distemper, dry, colour as required
IS 428	Specification for distemper, washable
IS 5410	Specification for cement paint, colour as required
IS 5411	Specification for plastic emulsion paint:
Part-1	For interior use
Part -2	For exterior use

(b) Ready mixed paints, enamels and powder coatings

Std: No	Title
ASTM D 5382	Specification for powder coatings
IS 101	Methods of sampling and test for paints, varnishes and related products
Part -1/ Sec 1	Test on liquid paints (general and physical), Section 1 sampling
Part 1/Sec 2	Test on liquid paints (general and physical), Section 2

	Preliminary examination and preparation of samples for testing
Part 1/Sec 3	Test on liquid paints (general and physical) section 3 preparation of panels
Part 1/Sec 4	Test on liquid paints (general and physical), Section 4 Brushing test
Part -1/Sec 5	Test on liquid paints (general and physical), Section 5 Consistency
Part 1/Sec 6	Test on liquid paints (general and physical), Section 6 Flash point
Part 1/Sec 7	Test on liquid paints (general and physical), Section 7 Mass per 10 liters
Part 2/ Sec 1	Test on liquid paints (chemical and examination), Section 1 Water content
Part 2/ Sec 2	Test on liquid paints (chemical examination), Section 2 Volatile matter
Part 3/Sec 1	Tests on paint film formation, Section 1 Drying time
Part 3/Sec 2	Tests on paint film formation, Section 2 Film thickness
Part 3/ Sec 4	Tests on paint film formation, Section 4 Finish
Part 3/Sec 5	Tests on paint film formation, Section 5 Fineness of grind
Part 4/ Sec 1	Optical test, section 1 opacity
Part 4/Sec 2	Optical test, section 2 colour
Part 4/Sec 3	Optical test, section 3 light fastness test
Part 4/Sec 4	Optical test, Section 4 Gloss
Part 5/Sec 1	Mechanical test on paint films, Section 1 Hardness tests
Part 5/Sec 2	Mechanical test on paint films, Section 2 Flexibility and adhesion
Part 5/Sec 3	Mechanical test on paint films, Section 3 Impact resistance
Part 5/Sec 4	Mechanical test on paint films, Section 4 Print free test
Part 6/Sec 1	Durability tests, section 1 resistance to humidity under conditions of condensation
Part 6/Sec 2	Durability tests, section 2 keeping properties
Part 6/Sec 3	Durability tests, section 3 moisture vapour permeability
Part 6/Sec 4	Durability tests, section 4 degradation of coatings (pictorial aids for evaluation)
Part 6/Sec 5	Durability tests, section 5 accelerated weathering test
Part 7/Sec 1	Environmental tests on paint films, section 1 resistance to water
Part 7/Sec 2	Environmental tests on paint films, section 2 resistance to liquid
Part 7/Sec 3	Environmental tests on paint films, section 3 resistance to heat
Part 7/Sec 4	Environmental tests on paint films, section 4 resistance to bleeding of pigments
Part 8/Sec 1	Tests for pigments and other solids, section 1 residue on sieve
Part 8/Sec 2	Environmental tests on paint films, section 2 pigments and non-volatile matter
Part 8/Sec 3	Environmental tests on paint films, section 3 ash content
Part 8/Sec 4	Environmental tests on paint films, section 4 phthalic anhydride
Part 8/Sec 5	Environmental tests on paint films, section 5 lead restriction test

Part 8/Sec 6	Environmental tests on paint films, section 8 volumes solids
Part 9/Sec 1	Tests for lacquers and varnish, Section 1 acid value
Part 9/Sec 2	Tests for lacquers and varnish, Section 2 rosin test
IS 104	Specification for ready mixed paint, brushing, zinc chrome, priming
IS 133	Specification for enamel, interior (a) undercoating, (b) finishing
IS 158	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, and heat resisting
IS 168	Specification for ready mixed paint, air-drying semi-glossy/matt, for general purposes
IS 2074	Specification for ready mixed paint and air-drying red oxide-zinc chrome, priming
IS 2075	Specification for ready mixed paint, stoving, red oxide-zinc chrome, priming
IS 2339	Specification for aluminium paint for general purposes, in dual container
IS 2932	Specification for enamel, synthetic exterior, (a) undercoating, (b) finishing
IS 2933	Specification for enamel, exterior, (a) undercoating (b) finishing
IS 3536	Specification for ready mixed paint, brushing, wood primer
IS 3585	Specification for ready mixed paint, aluminium, brushing, priming, water resistant, for wood work
IS 3678	Specification for ready mixed paint, thick white, for lettering
IS 8662	Specification for enamel, synthetic, exterior (a) undercoating, (b) finishing, for railway coaches
IS 11883	Specification for ready mixed paint, brushing, red oxide, priming for metals
IS 13183	Specification for aluminium paints, heat resistant
IS 13213	Specification for polyurethane full gloss enamel (two pack)

(c) Thinners and solvents

Std: No	**Title**
IS 14314	Specification for thinner general purposes for synthetic paints and varnishes
IS 82	Methods of sampling and test for thinners and solvents for paints

(d) Varnishes and lacquers

Std: No	**Title**
IS 337	Specification for varnish, finishing, interior
IS 347	Specification for varnish, shellac, for general purposes
IS 348	Specification for French polish
IS 524	Specification for varnish, finishing, exterior, synthetic
IS 525	Specification for varnish, finishing, exterior and general purposes

IS 642	Specification for varnish medium for aluminium paint

6.5.2.13. Polymers, Plastic and Geosynthetics/Geotextiles

Std:/Spec: No.	Title
ISO 527	Plastics — Determination of tensile properties
ISO 1183	Plastics — Methods for determining the density of non-cellular plastics
IS 1998	Methods of test for thermosetting synthetic resin bonded laminated sheets
IS 2036	Specification for phenolic laminated sheets
IS 2046	Specification for decorative thermosetting synthetics resin bonded laminated sheets
IS 2076	Specification for unsupported flexible vinyl film and sheeting
IS 2508	Specification for Polyethylene films and sheets
IS 6307	Specification for rigid PVC sheets
IS 9766	Specification for flexible PVC compound
IS 10889	Specification for high density polyethylene films
IS 12830	Specification for rubber-based adhesives for fixing PVC tiles to cement
IS 13162	Methods of test for geotextiles
ASTM D 1929-14	Standard Test Method for Determining Ignition Temperature of Plastics
ASTM D 4354	Standard practice for sampling Geosynthetics and rolled erosion control products (RECPs) for testing
ASTM D4355/D4355M	Standard test method for deterioration of geotextiles by exposure to light, moisture and heat in a xenon arc-type apparatus
ASTM D 4491	Standard test methods for water permeability of geotextiles by permittivity
ASTM D 4533	Standard test method for trapezoid tearing strength of geotextiles
ASTM D 4595	Standard test method for tensile properties of geotextiles by the wide-width strip method
ASTM D 4751	Standard test method for determining apparent opening size of a geotextile
ASTM D 4833/D4833M	Standard test method for index puncture resistance of geomembranes and related products
ASTM D 4886	Standard test method for abrasion resistance of geotextiles (sandpaper/sliding block method)
ASTM D 5199	Standard test method for measuring the nominal thickness of geosynthetics
ASTM D 5261	Standard test method for measuring mass per unit area of geotextiles
ASTM D 5262	Standard test method for determining the unconfined tension creep and creep rupture behavior of planar geosynthetics used

	for reinforcement purposes
ASTM D 5321/D5321M	Standard test method for determining the shear strength of soil-geosynthetic and geosynthetic-geosynthetic interfaces by direct shear
IS 13262	Specification for pressure sensitive adhesive tapes with plastic base
IS 13325	Method of test for the determination to tensile properties of extruded polymer geogrids using the wide strip
IS 14182	Specification for solvent cement for use with unplasticized polyvinyl chloride plastic pipe and fittings
IS 14443	Specification for polycarbonate sheets
IS 14643	Specification for unsintered polytera fluorethy (PTFE) tape for thread sealing applications
IS 14715	Specification for woven jute geotextiles
IS 14753	Specification for poly (methyl) methacrylate (PMMA) (Acrylic) sheets
IS 14986	Guidelines for application of jute geo-grid for rainwater erosion control in road and railway embankments and hill slopes
IS 15060	Tensile tests for joint/seams by wide width method of geotextiles

6.5.2.14. Materials for Water Supply, Drainage and Sanitation

6.5.2.14.1 Sanitary Appliances and Water Fittings

Std:/Spec: No.	Title
IS 404	Specification for lead pipes: part 1 for other than chemical purposes
IS 458	Specification for precast concrete pipes (with and without reinforcement)
IS 651	Specification for salt glazed stoneware pipes and fittings
IS 771	Specification for glazed fire-clay sanitary appliances:
Part 1	General requirements
Part 2	Specification requirements of kitchen and laboratory sinks
Part 3	Specification requirements of urinals, Section 1 slab urinals
Part 3/sec 2	Specification requirements of urinals, Section 2 stall urinals
Part 4	Specification requirements of postmortom slabs
Part 5	Specific requirements of shower trays
Part 6	Specific requirements of bed-pan sinks
Part 7	Specific requirements of slop sinks
IS 772	Specification for general requirements for enamelled cast iron sanitary appliances
IS 773	Specification for enamelled cast iron water-closets railway coaching stock type
IS 774	Specification for flushing cistern for water-closets and urinals (other than plastic cistern)
IS 775	Specification for cast iron brackets and supports for washbasins and sinks

IS 782	Specification for caulking lead
IS 804	Specification for rectangular pressed steel tanks
IS 1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS 1537	Specification for vertically cast iron pressure pipes for water, gas and sewage
IS 1538	Specification for cast iron fittings for pressure pipes for water, gas and sewage
IS 1700	Specification for drinking fountains
IS 1729	Specification for cast iron ductile iron drainage pipes and pipe fittings for grand non-pressure pipe line socket and spigot series
IS 1916	Specification for steel cylinder with concrete lining and coating
IS 2065	Code of practice for water supply in buildings
IS 2082	Stationary storage type electric water heaters
IS 2326	Specification for automatic flushing cisterns for urinals
IS 2470	Code of practice for installation of septic tanks
IS 2548	Specification for plastic seats and covers for water-closets:
Part 1	Thermoset seats and covers
Part 2	Thermo plastic seats and covers
IS 2556	Specification for vitreous sanitary appliances
Part 1	General requirements
Part 2	Specific requirements of wash-down water-closets
Part 3	Specific requirements of squatting pans
Part 4	Specific requirements of wash basins
Part 5	Specific requirements of laboratory sinks
Part 6	Specific requirements of urinals and partition plates
Part 7	Specific requirements of accessories for sanitary appliances
Part 8	Specific requirements of siphonic wash-down water-closets
Part 9	Specific requirements of bidets
IS 2692	Specification for ferrules for water services
IS 3006	Specification for chemically resistant salt glazed stone wear pipes and fittings
IS 3076	Specification for low density polyethylene pipes for potable water supplies
IS 3489	Specification for enameled steel bath tubs
IS 3989	Specification for centrifugally cast (spun) spigot and socket-soil, waste and ventilating pipes and fittings and accessories
IS 4111	Code of practice for ancillary structures in sewerage system: Part 1 Manholes
IS 4350	Specification for concrete porous pipes for under drainage
IS 4984	Specification for high density polyethylene pipes for potable water supplies
IS 4985	Specification for unplasticized PVC pipes for potable water supplies
IS 5455	Specification for cast iron steps for manholes
IS 6411	Specification for gel-coated glass fiber reinforced polyester

	resin bath tubs
IS 6784	Method for performance testing of water meters (domestic type)
IS 7181	Specification for horizontally cast iron double flanged pipes for water, gas and sewage
IS 7231	Specification for plastic flushing cisterns for water-closets and urinals
IS 7319	Specification for perforated concrete pipes
IS 8718	Specification for vitreous enameled steel kitchen sinks
IS 8727	Specification for vitreous enameled steel washbasins
IS 8931	Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services
IS 9076	Specification for vitreous integrated squatting pans for marine use
IS 9338	Specification for cast iron screw-down stop valves and stop and check valves for water works purposes
IS 9739	Specification for pressure reducing valves for domestic water supply systems
IS 9758	Specification for flush valves and fittings for water closets and urinals
IS 11246	Specification for glass fiber reinforced polyester resins (GRP) squatting pans
IS 12592	Specification for precast concrete manhole covers and frame
IS 13114	Specification for forged brass gate, globe and check valves for water works purposes
IS 13592	Specification for UPVC pipes for soil and waste discharge systems inside buildings including ventilation and rainwater system
IS 13983	Specification for stainless steel sinks for domestic purposes
IS 14333	Specification for high density polyethylene pipe for sewerage
IS 14735	Specification for unplasticized polyvinyl chloride (UPVC) injection moulded fittings for soil and waste discharge system for inside and outside buildings including ventilation and rain water system

6.5.2.14.2 Water Supply and Distribution

6.5.2.14.2.1 Water Service Pipe

Std:/Spec: No.	Title
ASTM D1527	Specification for Acrylonitrile butadiene styrene (ABS) plastic pipe, Schedules 40 and 80
ASTM D2282	Specification for Acrylonitrile butadiene styrene (ABS) plastic pipe (SDR-PR)
ASTM D2846	Specification for Chlorinated polyvinyl chloride (CPVC) plastic Hot and Cold-water distribution system
ASTM F441	Specification for Chlorinated polyvinyl chloride (CPVC) plastic pipe, Schedules 40 and 80
ASTM F442	Specification for Chlorinated polyvinyl chloride (CPVC) plastic pipe (SDR-PR)

CSA B137.6	CPVC pipe, tubing and fittings for hot and cold water distribution systems
ASTM F2855	Specification for Chlorinated polyvinyl chloride /aluminum/ chlorinated polyvinyl chloride (CPVC/AL/CPVC) Composite Pressure Tubing
ASTM B42	Specification for Seamless Copper pipe, Standard sizes
ASTM B302	Specification for Threadless Copper pipe, Standard sizes
ASTM B75	Specification for Seamless Copper Tube
ASTM B88	Specification for Seamless Copper water Tube
ASTM B251	Specification for General requirements for Wrought Seamless Copper or copper-alloy tube
ASTM B447	Specification for Welded Copper Tube
ASTM F876	Specification for Cross-linked polyethylene (PEX) tubing
AWWA C904	Cross-linked polyethylene (PEX) pressure tubing ½" through 3" for water services
CSA B137.5	Cross-linked polyethylene (PEX) tubing systems for pressure applications
ASTM F1281	Specification for Cross-linked polyethylene/aluminum/ cross-linked polyethylene (PEX-AL-PEX) pressure pipe
ASTM F2262	Specification for Cross-linked polyethylene/aluminum/ cross-linked polyethylene (PEX-AL-PEX) tubing OD Controlled SDR9
CSA B137.10	Cross-linked polyethylene/aluminum/ cross-linked polyethylene (PEX-AL-PEX) composite pressure pipe systems
ASTM F1986	Specification for Multilayer pipe, Type 2, Compression Fitting and Compression Joint for Hot and Cold drinking water system
AWWAC151/A21.51	Ductile iron water pipe, centrifugally cast for water
AWWAC115/A21.15	Flanged Ductile iron pipe with ductile-iron or gray iron threaded flanges
ASTM A53	Specification for pipe, steel, black and hot-dipped, zinc coated welded and seamless
ASTM D2239	Standard Specification for Polyethylene (PE) plastic pipe (SDR-PR) Based on Control Inside Diameter
ASTM D3035	Standard Specification for Polyethylene (PE) plastic pipe (DR-PR) Based on Control Outside Diameter
AWWA C901	Polyethylene (PE) pressure pipe and tubing ½" through to 3" for water services
CSA B137.11	Polypropylene (PPR) Pipe and fittings for pressure applications
ASTM D2737	Specification for Polyethylene (PE) plastic tubing
CSA B137.1	Polyethylene (PE) pipe, tubing and fittings for cold water pressure services
ASTM F1282	Standard Specification for Polyethylene / aluminum / polyethylene (PE-AL-PE) composite pressure pipe
CSA B137.9	Polyethylene/aluminum/polyethylene (PE-AL-PE) composite pressure pipe systems
ASTM F2769	Specification for Polyethylene of raised temperature (PE-RT)

	plastic Hot and Cold water tubing and distribution systems
CSA B137.18	Polyethylene of raised temperature (PE-RT) tubing systems for pressure applications
ASTM F2389	Specification for Pressure rated Polypropylene (PP) piping systems
ASTM D1785	Specification for Polyvinyl chloride (PVC) plastic pipe, Schedule 40, 80 and 120
ASTM D2241	Specification for Polyvinyl chloride (PVC) Pressure rated pipe (SDR Series)
ASTM D2672	Specification for Joints for IPS PVC pipe using solvent cement
CSA B137.3	Rigid Polyvinyl chloride (PVC) pipe for pressure applications
ASTM A312	Specification for Seamless, welded and heavily cold worked Austenitic Stainless-steel pipe
ASTM A778	Specification for Welded unannealed Austenitic Stainless steel tubular products

6.5.2.14.2.2 Water Distribution Pipe

Std:/Spec: No.	Title
ASTM D2846	Specification for Chlorinated polyvinyl chloride (CPVC) plastic Hot and Cold-water distribution system
ASTM F441	Specification for Chlorinated polyvinyl chloride (CPVC) plastic pipe, Schedules 40 and 80
ASTM F442	Specification for Chlorinated polyvinyl chloride (CPVC) plastic pipe (SDR-PR)
CSA B137.6	CPVC pipe, tubing and fittings for hot and cold water distribution systems
ASTM F2855	Specification for Chlorinated polyvinyl chloride/ aluminum/ chlorinated polyvinyl chloride (CPVC/AL/CPVC) Composite Pressure Tubing
ASTM B42	Specification for Seamless Copper pipe, Standard sizes
ASTM B302	Specification for Threadless Copper pipe, Standard sizes
ASTM B43	Specification for Seamless red brass pipe, standard sizes
ASTM B75	Specification for Seamless Copper Tube
ASTM B88	Specification for Seamless Copper water Tube
ASTM B251	Specification for General requirements for Wrought Seamless Copper or copper-alloy tube
ASTM B447	Specification for Welded Copper Tube
ASTM F876	Specification for Cross-linked polyethylene (PEX) tubing
CSA B137.5	Cross-linked polyethylene (PEX) tubing systems for pressure applications
ASTM F1281	Specification for Cross-linked polyethylene/aluminum/ cross-linked polyethylene (PEX-AL-PEX) pressure pipe
ASTM F2262	Specification for Cross-linked polyethylene/aluminum/ cross-linked polyethylene (PEX-AL-PEX) tubing OD Controlled SDR9
CSA B137.10	Cross-linked polyethylene/aluminum/ cross-linked polyethylene

	(PEX-AL-PEX) composite pressure pipe systems
ASTM F1986	Specification for Multilayer pipe, Type 2, Compression Fitting and Compression Joint for Hot and Cold drinking water system
AWWAC151/A21.51	Ductile iron water pipe, centrifugally cast for water
AWWAC115/A21.15	Flanged Ductile iron pipe with ductile-iron or gray iron threaded flanges
ASTM A53	Specification for pipe, steel, black and hot-dipped, zinc coated welded and seamless
ASTM F1282	Standard Specification for Polyethylene / aluminum / polyethylene (PE-AL-PE) composite pressure pipe
ASTM F2769	Specification for Polyethylene of raised temperature (PE-RT) plastic Hot and Cold-water tubing and distribution systems
CSA B137.18	Polyethylene of raised temperature (PE-RT) tubing systems for pressure applications
ASTM F2389	Specification for Pressure rated Polypropylene (PP) piping systems
CSA B137.11	Polypropylene (PPR) Pipe and fittings for pressure applications
ASTM A312	Specification for Seamless, welded and heavily cold worked Austenitic Stainless-steel pipe
ASTM A778	Specification for Welded unannealed Austenitic Stainless steel tubular products

6.5.2.14.2.3 Valves

Std:/Spec: No.	**Title**
ASME A112.4.14	Manually Operated, Quarter-Turn Shutoff Valves for Use in Plumbing Systems
ASME A112.18.1	Plumbing Supply Fittings
ASTM F1970	Special Engineered Fittings, Appurtenances or Valves for PVC or CPVC systems
CSA B125.3	Plumbing Fittings
IMPMO Z1157	Ball Valves
MSS SP-122	Plastic industrial ball valves
ASME B16.34	Valves – Flanged, Threaded and Welding End
MSS SP-67	Butterfly Valves
MSS SP-80	Bronze Gate, Globe, Angle and Check Valves
MSS SP-110	Ball Valves, threaded, Socket Welding, Solder Joint, Grooved and Flared Ends
MSS SP-139	Copper Alloy Gate, Globe, Angle and Check Valves for low pressure/ low temperature plumbing applications
NSF 359	Valves for Cross-linked Polyethylene (PEX) Water Distributing Tubing Systems
AWWA C500	Standard for Metal-seated Gate Valves for Water Supply Service
AWWA C504	Standard for Rubber-Seated Butterfly Valves
AWWA C507	Standard for Ball Valves
MSS SP-70	Gray iron Gate Valve, Flanged and Threaded Ends

MSS SP-71	Gray iron Swing Check Valve, Flanged and Threaded Ends
MSS SP-72	Ball Valves with Flanged or Butt-welding Ends for general services
MSS SP-78	Cast Iron Plug valves, Flanged and Threaded Ends
ASTM F2389	Specification for Pressure rated Polypropylene (PP) piping systems
ASTM F1970	Special Engineered Fittings, Appurtenances or Valves for PVC or CPVC systems
NSF 61	Drinking Water Systems Components – Health Effects

6.5.2.14.2.4 Pipe Fittings

Std:/Spec: No.	**Title**
ASTM D2468	Specification for Acrylonitrile butadiene styrene (ABS) plastic Pipe Fittings, Schedule 40
ASME B16.4	Gray iron threaded fittings class 125 and 250
ASSE 1061	Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe Fittings
ASTM D2846	Specification for Chlorinated polyvinyl chloride (CPVC) plastic Hot and Cold water distribution system
ASTM F437	Specification for Threaded Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Specification for Socket type Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80
CSA B137.6	CPVC pipe, tubing and fittings for hot and cold water distribution systems
ASME B16.15	Cast alloy threaded Fittings: Class 125 and 250
ASME B16.18	Cast copper alloy solder joint pressure fittings
ASME B16.22	Wrought copper and copper alloy solder joint pressure fittings
ASME B16.26	Cast copper alloy fittings for flared copper tubes
ASME B16.51	Standard Specification for Copper or copper alloy Pipe Fittings
ASTM F1476	Standard Specification for Performance of Gasketed Mechanical Couplings used in Piping Applications
ASTM F1548	Standard Specification for Performance of Fittings for use with Gasketed Mechanical Couplings used in Piping Applications
ASTM F1986	Specification for Multilayer pipe, Type 2, Compression Fitting and Compression Joint for Hot and Cold drinking water system
ASTM F877	Specification of Fittings for PEX Hot and Cold water distribution systems
ASTM F1807	Specification of Metal insert Fittings Utilizing a copper crimp ring for SDR9 for PEX tubing and PE-RT tubing
ASTM F1960	Specification of Cold expansion Fittings with PEX reinforcing rings for use with PEX tubing
ASTM F2080	Specification of Cold expansion Fittings with metal compression sleeves for PEX pipe

ASTM F2098	Specification of Stainless steel clamps for securing SDR9 PEX tubing to metal insert and plastic fittings
ASTM F2159	Specification of plastic insert fittings utilizing a copper crimp ring for SDR9 PEX tubing and PE-RT tubing
ASTM F2434	Specification of plastic insert fittings utilizing a copper crimp ring for SDR9 PEX tubing and PEX-AL-PEX tubing
ASTM F2735	Specification of plastic insert fittings utilizing a copper crimp ring for SDR9 PEX tubing and PE-RT tubing
CSA B137.5	Cross-linked polyethylene (PEX) tubing systems for pressure applications
ASTM D3261	Specification for butt-heat fusion PE plastic fittings for PE plastic pipe and tubing
ASTM F2769	Specification for Polyethylene of raised temperature (PE-RT) plastic Hot and Cold water tubing and distribution systems
CSA B137.18	Polyethylene of raised temperature (PE-RT) tubing systems for pressure applications
AWWAC110/A21.10	Ductile iron and gray iron Fittings
AWWAC153/A21.53	Ductile-iron compact Fittings for water services
ASTM F1974	Specification of metal insert fittings for PE-AL-PE pipe and PEX-AL-PEX composite pressure pipe
ASTM F1281	Specification for Cross-linked polyethylene/aluminum/ cross-linked polyethylene (PEX-AL-PEX) pressure pipe
ASTM F1282	Standard Specification for Polyethylene/aluminum/ polyethylene (PE-AL-PE) composite pressure pipe
CSA B137.9	Polyethylene/aluminum/polyethylene (PE-AL-PE) composite pressure pipe systems
CSA B137.10	Cross-linked polyethylene/aluminum/ cross-linked polyethylene (PEX-AL-PEX) composite pressure pipe systems
ASME B16.3	Malleable iron threaded Fittings class 150 and 300
ASTM D2609	Specification of plastic insert Fittings for Polyethylene (PE) plastic pipe
ASTM D2683	Specification of socket type Polyethylene (PE) fittings for outside diameter controlled PE pipe and tubing
ASTM F1055	Specification for electrofusion type Polyethylene (PE) fittings for outside diameter controlled PE and PEX pipe and tubing
CSA B137.1	Polyethylene (PE) pipe, tubing and fittings for cold water pressure services
ASTM F2389	Specification for Pressure rated Polypropylene (PP) piping systems
CSA B137.11	Polypropylene (PPR) Pipe and fittings for pressure applications
ASTM D2464	Specification for threaded Polyvinyl chloride (PVC) pipe fittings, Schedule 80
ASTM D2466	Specification for Polyvinyl chloride (PVC) plastic fittings, Schedule 40
ASTM D2467	Specification for Polyvinyl chloride (PVC) plastic fittings, Schedule 80

CSA B137.2	Polyvinyl chloride (PVC), Injection moulded gasketed fittings for pressure applications
CSA B137.3	Rigid Polyvinyl chloride (PVC) pipe for pressure applications
ASTM A312	Specification for Seamless, welded and heavily cold worked Austenitic Stainless steel pipe
ASTM A778	Specification for Welded unannealed Austenitic Stainless steel tubular products
ASME B16.9	Factory made wrought steel butt welding Fittings
ASME B16.11	Forged fittings, socket welding and threaded
ASME B16.28	Wrought steel butt welding short radius elbow and returns
ASTM F1476	Standard Specification for Performance of Gasketed Mechanical Couplings used in Piping Applications
ASTM F1548	Standard Specification for Performance of Fittings for use with Gasketed Mechanical Couplings used in Piping Applications

6.5.2.14.3 Sanitary Drainage

6.5.2.14.3.1 Above – Ground Drainage and Vent Pipe Material

Std:/Spec: No.	Title
ASTM D2661	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe and fittings
ASTM F628	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe with Cellular Core
ASTM F1488	Specification for Coextruded Composite Pipe
CSA B181.1	Acrylonitrile butadiene styrene (ABS) Drain, Waste and Vent pipe and pipe fittings
ASTM A74	Specification for Cast-iron soil pipe and fittings
ASTM A888	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
CISPI 301	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
ASTM B42	Specification for Seamless Copper pipe, Standard sizes
ASTM B302	Specification for Threadless Copper pipe, Standard sizes
ASTM B43	Specification for Seamless red brass pipe, standard sizes
ASTM B75	Specification for Seamless Copper Tube
ASTM B88	Specification for Seamless Copper water Tube
ASTM B251	Specification for General requirements for Wrought Seamless Copper or copper-alloy tube
ASTM B306	Specification for Copper Drainage Tube (DWV)
ASTM A53	Specification for pipe, steel, black and hot-dipped, zinc coated welded and seamless
ASTM C1053	Specification for Borosilicate Glass pipe and fittings for Drain, Waste, and Vent (DWV) Applications
ASTM F1412	Specification for Polyolefin pipe and fittings for Corrosive Waste Drainage

CSA B181.3	Polyolefin pipe and Polyvinylidene fluoride (PVDF) Laboratory drainage system
ASTM D2665	Specification for Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM F891	Specification for coextruded Polyvinyl chloride (PVC) plastic pipe with a cellular core
ASTM F1488	Specification for Coextruded Composite Pipe
CSA B181.2	PVC and CPVC Drain, waste and vent pipe and pipe fittings
ASTM D2949	Specification for 3.25 in Outside Diameter Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM F1673	Specification for Polyvinylidene fluoride (PVDF) corrosive waste drainage systems
ASME A112.3.1	Stainless steel drainage systems for sanitary, DWV, Storm and Vacuum application and above and below ground

6.5.2.14.3.2 Underground Drainage and Vent Pipe Material

Std:/Spec: No.	Title
ASTM D2661	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe and fittings
ASTM F628	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe with Cellular Core
ASTM F1488	Specification for Coextruded Composite Pipe
CSA B181.1	Acrylonitrile butadiene styrene (ABS) Drain, Waste and Vent pipe and pipe fittings
ASTM A74	Specification for Cast-iron soil pipe and fittings
ASTM A888	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
CISPI 301	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
ASTM B75	Specification for Seamless Copper Tube
ASTM B88	Specification for Seamless Copper water Tube
ASTM B251	Specification for General requirements for Wrought Seamless Copper or copper-alloy tube
ASTM B306	Specification for Copper Drainage Tube (DWV)
ASTM F714	Standard Specification for Polyethylene (PE) plastic pipe (SDR-PR) based on outside diameter
ASTM F1412	Specification for Polyolefin pipe and fittings for Corrosive Waste Drainage
CSA B181.3	Polyolefin pipe and Polyvinylidene fluoride (PVDF) Laboratory drainage system
ASTM D2665	Specification for Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM F891	Specification for coextruded Polyvinyl chloride (PVC) plastic pipe with a cellular core

CSA B181.2	PVC and CPVC Drain, waste and vent pipe and pipe fittings
ASTM D2949	Specification for 3.25 in Outside Diameter Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM F1673	Specification for Polyvinylidene fluoride (PVDF) corrosive waste drainage systems
CSA B181.3	Polyolefin pipe and Polyvinylidene fluoride (PVDF) Laboratory drainage system
ASME A112.3.1	Stainless steel drainage systems for sanitary, DWV, Storm and Vacuum application and above and below ground

6.5.2.14.3.3 Building Sewer Pipe

Std:/Spec: No.	Title
ASTM D2661	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe and fittings
ASTM F628	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe with Cellular Core
ASTM F1488	Specification for Coextruded Composite Pipe
CSA B181.1	Acrylonitrile butadiene styrene (ABS) Drain, Waste and Vent pipe and pipe fittings
ASTM D2751	Specification for Acrylonitrile butadiene styrene (ABS) sewer pipe and fittings
ASTM A74	Specification for Cast-iron soil pipe and fittings
ASTM A888	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
CISPI 301	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
ASTM C14	Specification for Nonreinforced Concrete sewer, Storm drain and culvert pipe
ASTM C76	Specification for Reinforced Concrete culvert, storm drain and sewer pipe
CSA A257.1	Non-reinforced Circular Concrete culvert, storm drain, sewer pipe and fittings
CSA A257.2	Reinforced Circular Concrete culvert, storm drain, sewer pipe and fittings
ASTM B75	Specification for Seamless Copper Tube
ASTM B88	Specification for Seamless Copper water Tube
ASTM B251	Specification for General requirements for Wrought Seamless Copper or copper-alloy tube
ASTM F714	Standard Specification for Polyethylene (PE) plastic pipe (SDR-PR) based on outside diameter
ASTM F2736	Specification for 6 to 30 in Polypropylene (PP) corrugated single wall pipe and double wall pipe
ASTM F2764	Specification for 30 to 60 in Polypropylene (PP) triple wall pipe and fittings for non-pressure sanitary sewer applications
CSA B182.13	Profile Polypropylene (PP) sewer Pipe and fittings for leak-

	proof sewer applications
ASTM D2665	Specification for Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM F891	Specification for coextruded Polyvinyl chloride (PVC) plastic pipe with a cellular core
ASTM D3034	Specification for type PSM Polyvinyl chloride (PVC) sewer pipe and fittings
CSA B182.2	PSM type Polyvinyl chloride (PVC) sewer pipe and fittings
CSA B182.4	Profile Polyvinyl chloride (PVC) sewer pipe and fittings
ASTM D2949	Specification for 3.25 in Outside Diameter Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM F1673	Specification for Polyvinylidene fluoride (PVDF) corrosive waste drainage systems
CSA B181.3	Polyolefin pipe and Polyvinylidene fluoride (PVDF) Laboratory drainage system
ASME A112.3.1	Stainless steel drainage systems for sanitary, DWV, Storm and Vacuum application and above and below ground
ASTM C4	Specification for Clay drain tile and perforated clay drain tile
ASTM C700	Specification for Vitrified clay Pipe, Extra strength, Standard Strength, and perforated

6.5.2.14.3.4 Pipe Fittings

Std:/Spec: No.	**Title**
ASTM D2661	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe and fittings
ASTM F628	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe with Cellular Core
CSA B181.1	Acrylonitrile butadiene styrene (ABS) Drain, Waste and Vent pipe and pipe fittings
ASTM D2751	Specification for Acrylonitrile butadiene styrene (ABS) sewer pipe and fittings
ASME B16.4	Gray iron threaded fittings class 125 and 250
ASME B16.12	Cast iron threaded drainage Fittings
ASTM A74	Specification for Cast-iron soil pipe and fittings
ASTM A888	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
CISPI 301	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
ASME B16.15	Cast alloy threaded Fittings: Class 125 and 250
ASME B16.18	Cast copper alloy solder joint pressure fittings
ASME B16.22	Wrought copper and copper alloy solder joint pressure fittings
ASME B16.23	Cast copper alloy solder joint drainage fittings DWV
ASME B16.26	Cast copper alloy fittings for flared copper tubes
ASME B16.29	Wrought copper and Wrought copper alloy solder joint drainage fittings DWV

ASTM C1053	Specification for Borosilicate Glass pipe and fittings for Drain, Waste, and Vent (DWV) Applications
AWWAC110/A21.10	Ductile iron and Gray iron Fittings
ASTM D2683	Specification of socket type Polyethylene (PE) fittings for outside diameter controlled PE pipe and tubing
ASTM F1412	Specification for Polyolefin pipe and fittings for Corrosive Waste Drainage
CSA B181.3	Polyolefin pipe and Polyvinylidene fluoride (PVDF) Laboratory drainage system
ASTM D2665	Specification for Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM F1866	Specification for Polyvinyl chloride (PVC) Schedule 40, drainage and DWV fabricated fittings
ASTM D3034	Specification for type PSM Polyvinyl chloride (PVC) sewer pipe and fittings
ASTM D2949	Specification for 3.25 in Outside Diameter Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM F1673	Specification for Polyvinylidene fluoride (PVDF) corrosive waste drainage systems
CSA B181.3	Polyolefin pipe and Polyvinylidene fluoride (PVDF) Laboratory drainage system
ASME A112.3.1	Stainless steel drainage systems for sanitary, DWV, Storm and Vacuum application and above and below ground
ASME B16.9	Factory made wrought steel butt welding Fittings
ASME B16.11	Forged fittings, socket welding and threaded
ASME B16.28	Wrought steel butt welding short radius elbow and returns
ASTM C700	Specification for Vitrified clay Pipe, Extra strength, Standard Strength, and perforated

6.5.2.14.4 Storm Drainage

6.5.2.14.4.1 Building Storm Sewer Pipe

Std:/Spec: No.	Title
ASTM D2661	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe and fittings
ASTM F628	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe with Cellular Core
ASTM F1488	Specification for Coextruded Composite Pipe
CSA B181.1	Acrylonitrile butadiene styrene (ABS) Drain, Waste and Vent pipe and pipe fittings
CSA B182.1	Acrylonitrile butadiene styrene (ABS) drain, waste and vent pipe and pipe fittings
ASTM A74	Specification for Cast-iron soil pipe and fittings
ASTM A888	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
CISPI 301	Specification for hubless Cast-iron soil pipe and fittings for

	Sanitary and Storm Drain, Waste and Vent piping application
ASTM C14	Specification for Nonreinforced Concrete sewer, Storm drain and culvert pipe
ASTM C76	Specification for Reinforced Concrete culvert, storm drain and sewer pipe
CSA A257.1	Non-reinforced Circular Concrete culvert, storm drain, sewer pipe and fittings
CSA A257.2	Reinforced Circular Concrete culvert, storm drain, sewer pipe and fittings
ASTM B75	Specification for Seamless Copper Tube
ASTM B88	Specification for Seamless Copper water Tube
ASTM B251	Specification for General requirements for Wrought Seamless Copper or copper-alloy tube
ASTM B306	Specification for Copper Drainage Tube (DWV)
ASTM F667	Specification for 3 through 24 in Corrugated Polyethylene (PE) pipe and fittings
ASTMF2306/F2306M12” to 60”	Annular Corrugated profile-wall Polyethylene (PE) pipe and Fittings for gravity flow storm sewer and subsurface drainage applications
ASTMF2648/F2648M2” to 60”	Annular Corrugated profile-wall Polyethylene (PE) pipe and Fittings for land drainage applications
ASTM F2881	12” to 60” Polypropylene (PP) dual wall pipe and fittings for non-pressure storm sewer applications
CSA B182.13	Profile Polypropylene (PP) sewer Pipe and fittings for leak-proof sewer applications
ASTM D2665	Specification for Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM D3034	Specification for type PSM Polyvinyl chloride (PVC) sewer pipe and fittings
ASTM F891	Specification for coextruded Polyvinyl chloride (PVC) plastic pipe with a cellular core
ASTM F1488	Specification for Coextruded Composite Pipe
CSA B181.2	PVC and CPVC Drain, waste and vent pipe and pipe fittings
CSA B182.4	Profile Polyvinyl chloride (PVC) sewer pipe and fittings
CSA B182.2	PSM type Polyvinyl chloride (PVC) sewer pipe and fittings
ASME A112.3.1	Stainless steel drainage systems for sanitary, DWV, Storm and Vacuum application and above and below ground
ASTM C4	Specification for Clay drain tile and perforated clay drain tile
ASTM C700	Specification for Vitrified clay Pipe, Extra strength, Standard Strength, and perforated

6.5.2.14.4.2 Subsoil Drain Pipe

Std:/Spec: No.	**Title**
ASTM A74	Specification for Cast-iron soil pipe and fittings
ASTM A888	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application

CISPI 301	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
ASTM F405	Specification for Corrugated Polyethylene (PE) pipe and fittings
ASTM F667	Specification for 3 through 24 in Corrugated Polyethylene (PE) pipe and fittings
CSA B182.1	Acrylonitrile butadiene styrene (ABS) drain, waste and vent pipe and pipe fittings
CSA B182.6	Profile Polyethylene (PE) sewer pipe and fittings for leak-proof sewer applications
CSA B182.8	Profile Polyethylene (PE) storm sewer and drainage pipe and fittings
ASTM D2729	Specification for Polyvinyl chloride (PVC) sewer pipe and fittings
ASTM D3034	Specification for type PSM Polyvinyl chloride (PVC) sewer pipe and fittings
ASTM F891	Specification for coextruded Polyvinyl chloride (PVC) plastic pipe with a cellular core
CSA B182.2	PSM type Polyvinyl chloride (PVC) sewer pipe and fittings
CSA B182.4	Profile Polyvinyl chloride (PVC) sewer pipe and fittings
ASME A112.3.1	Stainless steel drainage systems for sanitary, DWV, Storm and Vacuum application and above and below ground
ASTM C4	Specification for Clay drain tile and perforated clay drain tile
ASTM C700	Specification for Vitrified clay Pipe, Extra strength, Standard Strength, and perforated

6.5.2.14.4.3 Pipe Fittings

Std:/Spec: No.	**Title**
ASTM D2661	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe and fittings
ASTM F628	Specification for Acrylonitrile butadiene styrene (ABS) schedule 40, plastic drain, waste and vent pipe with Cellular Core
CSA B181.1	Acrylonitrile butadiene styrene (ABS) Drain, Waste and Vent pipe and pipe fittings
ASME B16.4	Gray iron threaded fittings class 125 and 250
ASME B16.12	Cast iron threaded drainage Fittings
ASTM A74	Specification for Cast-iron soil pipe and fittings
ASTM A888	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
CISPI 301	Specification for hubless Cast-iron soil pipe and fittings for Sanitary and Storm Drain, Waste and Vent piping application
ASTM D2665	Specifications for PVC Drain, Waste and Vent (DWV) pipe and Fittings
ASTM D3311	Specification for Drain, Waste and Vent (DWV) plastic Fittings patterns
ASTM F891	Specification for coextruded Polyvinyl chloride (PVC) plastic

	pipe with a cellular core
ASTM D3034	Specification for type PSM Polyvinyl chloride (PVC) sewer pipe and fittings
ASME B16.15	Cast alloy threaded Fittings: Class 125 and 250
ASME B16.18	Cast copper alloy solder joint pressure fittings
ASME B16.22	Wrought copper and copper alloy solder joint pressure fittings
ASME B16.23	Cast copper alloy solder joint drainage fittings DWV
ASME B16.26	Cast copper alloy fittings for flared copper tubes
ASME B16.29	Wrought copper and Wrought copper alloy solder joint drainage fittings DWV
AWWAC110/A21.10	Ductile iron and Gray iron Fittings
ASME B16.3	Malleable iron threaded Fittings class 150 and 300
ASTM F409	Specification of thermoplastic accessible and replaceable plastic tube and tubular Fittings
ASTMF2306/F2306M12" to 60"	Annular Corrugated profile-wall Polyethylene (PE) pipe and Fittings for gravity flow storm sewer and subsurface drainage applications
ASTM D2665	Specification for Polyvinyl chloride (PVC) plastic Drain, Waste and Vent Pipe and fittings
ASTM F1866	Specification for Polyvinyl chloride (PVC) Schedule 40, drainage and DWV fabricated fittings
ASME B16.9	Factory made wrought steel butt welding Fittings
ASME B16.11	Forged fittings, socket welding and threaded
ASME B16.28	Wrought steel butt welding short radius elbow and returns
ASME A112.3.1	Stainless steel drainage systems for sanitary, DWV, Storm and Vacuum application and above and below ground

6.5.2.15. Stones

(a) Specifications

Std:/Spec: No.	Title
ASTM C503/C503M-10	Specification for marble dimension stone
ASTM C568/C568M-10	Specification for limestone dimension stone
ASTM C615/C615M-11	Standard specification for granite dimension stone
ASTM C1364-10b	Standard specification for architectural cast stone
IS 3620	Specification for laterite stone block for masonry
IS 3622	Specification for sand stones (slabs and tiles)
IS 9394	Specification for stone lintels

(b) Methods of testing

Std:/Spec: No.	Title
ASTM C97/C 97M-15	Standard test methods for absorption and bulk specific gravity of dimension stone
ASTM C99/C99M-15	Test method for modulus of rupture of dimension stone
ASTM C110-15	Test methods for physical testing of quicklime, hydrated lime, and limestone
ASTM C170/C170M-15a	Test method for compressive strength of dimension stone

ASTM C241/C241M-15e1	Standard test method for abrasion resistance of stone subjected to foot traffic
ASTM C880/C880M-15	Standard test method for flexural strength of dimension stone
ASTM C1195-03(2011)	Standard test method for absorption of architectural cast stone
IS 1121	Tests for determination of strength properties of natural building stones Transverse strength Tensile strength Shear strength
IS 1122	Test for determination of true specific gravity of natural building stones
IS 1123	Methods of identification of natural building stones
IS 1125	Test for determination of weathering of natural building stones
IS 1126	Test for determination of durability of natural building stones
IS 1200	Methods of measurements of building and civil engineering works stone masonry
IS 4121	Test for determination of water transmission rate by capillary action through natural building stones
IS 4122	Test for surface softening of natural building stones by exposure to acidic atmosphere
IS 5218	Test for toughness of natural building stones
IS 43478	Test for determination of permeability of natural building stone

6.5.2.16. Structural Steel, Reinforcing Steel, Pre-Stressing and others

Std: No.	Title
ASTM C 645	Standard specification for non-structural steel framing members
ASTM A 36	Standard specification for carbon structural steel
ASTM A 53	Standard specification for Pipe, Steel, Black & Hot- Dipped, Zinc-coated, Welded and Seamless
ASTM A 82	Standard specification for steel wire, plain, for concrete reinforcement
ASTM A123	Standard specification for zinc (hot-dip galvanized) coatings on iron and steel products
ASTM A 194	Specification for carbon and alloy steel nuts for bolts for high pressure or high temperature service, or both
ASTM A 242	Specification for high strength low alloy structural steel
ASTM A 276	Specification for stainless steel bars and shapes
ASTM A 283	Specification for low and intermediate tensile strength carbon steel plates
ASTM A 320	Specification for alloy/steel bolting materials for low-temperature service
ASTM A 325/A 325 M	Standard specification for high-strength bolts for structural steel joints
ASTM A 370	Standards test methods and definitions for mechanical testing of steel products
ASTM A 416	Standard specification for Steel Strand, Uncoated Seven-wire

	for Prestressed Concrete
ASTM A 421	Standard specification for Stress-Relieved Steel Wire for Prestressed Concrete
ASTM A 423/A423M	Standard specification for seamless and electric-welded low-alloy steel tubes
ASTM A 492	Standard specification for stainless steel rope wire
ASTM A 496 M	Standard specification for steel wire, deformed, for concrete reinforcement
ASTM A 500	Standard specification for Cold-Formed Welded and Seamless, Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 501	Standard specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing in Runds and Shapes
ASTM A 510	Specification for general requirements for wire rods, course round wire, carbon steel
ASTM A 526	Standard specification for steel sheet, zinc-coated (galvanized) by the hot-dip process, commercial quality
ASTM A 555/A 555M	Standard specification for general requirements of stainless steel wire and wire rods
ASTM A 563	Specification for carbon and alloy steel nuts
ASTM A 568/A 568M	Standard specification for steel, sheet, carbon and high-strength, low-alloy, hot-rolled and cold-rolled, general requirement
ASTM A 572	Standard specification for high-strength low-alloy columbium-vanadium structural steel
ASTM A 580/A 580M	Specification for stainless steel wire
ASTM A 588/A 588M	Standard specification for High-Strength Low-Alloy Structural Steel
ASTM A 653	Specification for galvanized steel sheets
ASTM A 666	Standard specification for annealed or cold-worked austenitic stainless steel sheet, strip, plate and flat bar
ASTM A 706/A 706M	Standard specification for Deformed and Plain Low-Alloy Steel Bars for concrete reinforcement
ASTM A 722/A 722M	Standard specification for uncoated high-strength steel bars for prestressing concrete
ASTM A 759/A 759M	Standard specification for carbon steel crane rails
ASTM A 767/A 767 M	Standard specification for zinc-coated (Galvanized) steel bars for concrete reinforcement
ASTM A 775/A 775 M	Standard specification for epoxy-coated reinforcing steel bars
ASTM A 934/A 934 M	Standard specification for epoxy-coated prefabricated steel reinforcing bars
ASTM A 955	Standard specification for Deformed and Plain stainless-steel bars for concrete reinforcement
ASTM A 996/A996 M	Standard specification for Rail-Steel and Axel-Steel deformed bars for concrete reinforcement
ASTM A 992/A 992 M	Standard specification for steel for structural shapes for use in building framing
ASTM A 1044	Standard specification for Steel Stud Assemblies for shear

	reinforcement of concrete
ASTM A 1267	Standard specification for expended metal steel sheets for general purposes
ASTM C 1002	Standard specification for steel drill screws for the application of gypsum panel products or metal plaster bases
ASTM F 436	Specification for hardened steel washers
ASTM F 547	Standard terminology of nails for use with wood and wood-base materials
ASTM F 1667	Standard specification for driven fasteners: nails, spikes and staples
IS 432	Specifications for hollow mild steel sections for structural use
IS 1148	Specification for hot-rolled steel rivet bars (up to 40 mm diameter) for structural purposes
IS 1363	Specification for hexagonal wire netting for general purposes
IS 2041	Specification for steel plates for pressure vessels used at moderate and low temperature
IS 2502	Code of practice for bending and fixing of bars for concrete reinforcement
IS 8081	Specification for slotted sections
MMS ASTM A 615/A 615 M-18	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
MMS JIS G 3101: 2015	MMS JIS G 3101: 2015 Rolled steels for general structure
MMS JIS G 3106: 2015	MMS JIS G 3106: 2015 Rolled steels for welded structure
MMS JIS G 3131: 2018	MMS JIS G 3131: 2018 Hot-rolled mid steel plates, sheet and strip
MMS JIS G 3141: 2017	MMS JIS G 3141: 2017 Cold-reduced carbon steel sheet and strip
MMS JIS G 3192: 2014	MMS JIS G 3192: 2014 Dimensions, mass and permissible Variations of hot rolled steel sections
MMS JIS G 3193: 2019	Dimensions, shape, mass and permissible Variations of hot rolled steel plates, sheets and strips
MMS JIS G 3302: 2019	Hot-dip zinc-coated steel sheet and strip
MMS JIS G 3312: 2012	Prepainted hot-dip zinc-coated steel sheet and strip
MMS JIS G 3321: 2019	Hot-dip 55% Aluminium-Zinc alloy coated steel sheet and strip
MMS JIS G 3322: 2005	Pre painted Hot-dip 55% aluminium-zinc alloy coated steel sheet and strip
MMS JIS G 3466: 2015	Carbon steel square and rectangular tubes for general structure
MMS JIS G 3505: 2017	Low carbon steel wire rods
MMS JIS A 5523: 2012	Weldable hot rolled steel sheet piles
MMS JIS A 5528: 2012	Hot rolled steel sheet piles
MMS JIS G 0404: 2014	Steel and Steel Products – General Technical Delivery Requirements
MMS JIS G 0416: 2014	Steel and Steel Products _ Location and Preparation of Samples and Test Pieces for Mechanical Testing
MMS JIS G 1253: 2002	Iron and steel-Method for spark discharge atomic emission spectrometric analysis

MMS JIS Z 2241: 2012	Metallic Materials-Tensile testing Method of test at room temperature
MMS JIS Z 2244: 2009	Vickers Hardness Test - Test Method
MMS JIS Z 2245: 2016	Rockwell Hardness test - Test method

6.5.2.17. Thermal Insulation Materials

Std:/Spec: No.	Title
ASTM C 163	Practice for mixing thermal insulating cement samples
ASTM C 165	Test method for measuring compressive properties of thermal insulations
ASTM C 166	Test method for covering capacity and volume change upon drying of thermal insulating cement
ASTM C 578	Specification for rigid, cellular polystyrene thermal insulation
IS 3677	Specification for unbonded rock and slag wool for thermal insulation
IS 4671	Specification for expanded polystyrene for thermal insulation purposes
IS 6598	Specification for cellular concrete for thermal insulation
IS 7509	Specification for thermal insulating cement
IS 8154	Specification for performed calcium silicate insulation for temperatures up to 650Ċ
IS 8183	Specification for bonded mineral wool
IS 9489	Method of test for thermal conductivity of materials by means of heat flow meter
IS 9490	Method of determination for thermal conductivity of insulation materials (water calorimeter method)
IS 9742	Specification for sprayed mineral wool thermal insulation
IS 9743	Specification for thermal insulation finishing cements
IS 9842	Specification for preformed fibrous pipe insulation
IS 3144	Method of test for material wool thermal insulation material
IS 11128	Specification for spray applied hydrated calcium silicate thermal insulation
IS 11129	Method of test for tumbling friability of preformed block-type thermal insulation
IS 11239	Method of test for rigid cellular thermal insulation materials
Part- 1	Dimensions
Part - 2	Apparent density
Part - 3	Dimensional stability
Part - 4	Water vapour transmission rate
Part - 5	Volume percent of open and closed cells
Part - 6	Heat distortion temperature
Part - 7	Coefficient of linear thermal expansion at low temperatures
Part - 8	Flame height, time of burning and loss of mass
Part - 9	Water absorption

Part -10	Flexural strengths
Part -11	Compressive strength
Part -12	Horizontal burning characteristics
Part -13	Determination of flammability by oxygen index
IS 11307	Specification for cellular glass block and pipe thermal insulating
IS 11308	Specification for thermal insulating castables (hydraulic setting) for temperature up to 250 °C
IS 12436	Specification for preformed rigid polyurethane (PUR) and polyisocyanurate (PIR) foams for thermal insulation
IS 13204	Specification for rigid phenolic foams for thermal insulation
IS 13286	Method of test for surface spread of flame for thermal insulation materials

6.5.2.18. Wood Based Materials

Std:/Spec: No.	**Title**
ASTM D 9	Terminology relating to wood and wood-based products
ASTM D 25	Specification for round timber piles
ASTM D 38	Test methods for sampling wood preservatives prior to testing
ASTM D 143	Test methods for small clear specimens of timber
ASTM D 198	Test methods of static tests of lumber in structural sizes
ASTM D 245	Practice for establishing structural grades and related allowable properties for visually graded lumber
ASTM D 246	Test method for distillation of creosote and creosote-coal tar solutions
ASTM D 390	Specification for coal-tar creosote for the preservative treatment of piles, poles, and timbers for marine, land, and freshwater use
ASTM D1036	Test methods of static tests of wood poles
ASTM D 1037	Test methods for evaluating properties of wood-based fiber and particle panel materials
ASTM D 1038	Terminology relating to veneer and plywood
ASTM D 1110	Test methods for water solubility of wood
ASTM D 1165	Nomenclature of commercial hardwoods and softwoods
ASTM D 1166	Test method for methoxyl groups in wood and related materials
ASTM D 1554	Terminology relating to wood-based fiber and particle panel materials
ASTM D 1666	Test methods for conducting machining tests of wood and wood-based materials
ASTM D 1760	Specification for pressure treatment of timber products
ASTM D 1761	Test methods for mechanical fasteners in wood
ASTM D 1990	Practice for establishing allowable properties for visually-graded dimension lumber from in-grade tests of full-size specimens
ASTM D 2017	Method of accelerated laboratory test of natural decay resistance of woods

ASTM D 2164	Methods of testing structural insulating roof deck
ASTM D 2394	Methods for simulated service testing of wood and wood-based finish flooring
ASTM D 2395	Test methods for density and specific gravity (relative density) of wood and wood-based materials
ASTM D 2481	Test method for accelerated evaluation of wood preservatives for marine services by means of small size specimens
ASTM D 2719	Test methods for structural panels in shear through-the-thickness
ASTM D 2898	Test methods for accelerated weathering of fire-retardant-treated wood for fire testing
ASTM D 2899	Practice for establishing allowable stresses for round timber piles
ASTM D 2915	Practice for evaluating allowable properties for grades of structural lumber
ASTM D 3043	Test methods for structural panels in flexure
ASTM D 3044	Test method for shear modulus of wood-based structural panels
ASTM D 3200	Specification and test method for establishing recommended design stresses for round timber construction poles
ASTM D 3499	Test method for toughness of wood-based structural panels
ASTM D 3500	Test methods for structural panels in tension
ASTM D 3501	Test methods for wood-based structural panels in compression
ASTM D 3737	Practice for establishing allowable properties for structural glued laminated timber (glulam)
ASTM D 4442	Test methods for direct moisture content measurement of wood and wood-based materials
ASTM D 4444	Test methods for use and calibration of hand-held moisture meters
ASTM D 4761	Test methods for mechanical properties of lumber and wood-based structural material
ASTM D 4933	Guide for moisture conditioning of wood and wood-based materials
ASTM D 5456	Specification for evaluation of structural composite lumber products
ASTM D 5516	Test method for evaluating the flexural properties of fire-retardant treated softwood plywood exposed to elevated temperatures
ASTM D 5536	Practice for sampling forest trees for determination of clear wood properties
ASTM D 5651	Test method for surface bond strength of wood-based fiber and particle panel materials
ASTM D 6815	Specification for evaluation of duration of load and creep effects of wood and wood-based products
IS 1708	
Part 3	Determination of volumetric shrinkage
Part 4	Determination of radial and tangential shrinkage and fiber

	situation point
Part 5	Determination of static bending strength
Part 6	Determination of static bending strength under two point loading
Part 7	Determination of impact bending strength
Part 8	Determination of compressive strength parallel to grain
Part 9	Determination of compressive strength perpendicular to grain
Part 10	Determination of hardness under static indentation
Part 11	Determination of shear strength parallel to grain
Part 12	Determination of tensile strength parallel to grain
Part 13	Determination of tensile strength perpendicular to grain
Part 15	Determination of nail and screw holding power
Part 18	Determination of torsional strength

6.5.2.19. Welding, electrodes and wires

Std:/ Spec: No	**Title**
AWS D1.1/ D1.1M (2020)	Structural Welding Code – Steel Part 7.3 Welding Consumables and Electrode Requirements Annex L (Informative) – Filler Metal Strength Properties Annex M (Informative) – AWS A 5.36 Filler Metal Classifications and Properties Table 5.4–Filler Metals for Matching Strength for Table 5.3, Group I, II, III and IV Metals-SMAW, SAW, FCAW and GMAW Metal Cored (see 5.6)
AWS D1.2/ D1.2M-2005	Structural Welding Code – Aluminium B 5.0B Filler Materials
AWS D1.3/ D1.3M-2008	Structural Welding Code – Sheet Steel Table 1.2 Matching Filler Metal Requirements
AWS D1.4/ D1.4M-2018	Structural Welding Code – Reinforcing Steel 7.1) Filler Metal Requirements 7.9) SMAW Electrodes 7.10) GMAW Electrodes 7.11) FCAW Electrodes 7.12) GTAW Electrodes & Filler Metals
AWS D1.5/ D1.5M-2015	Bridge Welding Code – A 6.1) Filler Metal Requirements B 6.5) Electrodes for SMAW C 6.8) Electrodes and Fluxes for SAW D 6.11) GMAW / FCAW Electrodes E 6.15) Condition of Electrodes and Guide Tubes F 6.21) Consumable Guide Electrical Insulators Annex H (Normative) ESW Consumable Requirement
AWS D1.6/ D1.6M-2017	Structural Welding Code – Stainless Steel Fabrication 7.3) Welding Consumable and Electrode Requirements
AWS D1.7/ D1.7M-2010	Guide for Strengthening and Repairing Existing Structures

AWS D1.8/ D1.8M-2021	Structural Welding Code – Seismic Supplement
AWS D1.9/ D1.9M-2015	Structural Welding Code – Titanium
IS 814	Specification for covered electrodes for manual metal arc welding of carbon and carbon manganese steel
IS 1278	Specification for filler rods and wires for gas welding
IS 1395	Specification for low and medium alloy steel covered electrodes for manual metal arc welding
IS 2879	Mild steel for metal arc welding electrodes
IS 3613	Acceptance tests for wire flux combinations for submerged arc welding of structural steel
IS 4972	Specification for resistance spot welding electrodes
IS 5206	Covered electrodes for manual arc welding of stainless steel and other similar high alloy steel
IS 5511	Specification for covered electrodes for manual arc welding cast iron
IS 5897	Specification for aluminium and aluminium alloy welding rods and wires and magnesium alloy welding rods
IS 5898	Specification for copper and copper alloy bare solid welding rods and electrodes
IS 6419	Specification for welding rods and bare electrodes for gas shielded arc welding of structural steel
IS 7280	Specification for bare wire electrodes for submerged arc welding of structural steel
IS 8363	Specification for bare wire electrodes for electroslag welding of steels
IS 10631	Stainless for welding electrode core wire

6.5.2.20. Wire Ropes and Wire Products

Std:/Spec: No.	**Title**
ASTM A 844/ A 844M	Standard specification for Epoxy coated steel wire and welded wire fabric for reinforcement
IS 278	Specification for galvanized steel barbed wire for fencing
IS 2140	Specification for stranded galvanized steel wire for fencing
IS 2266	Specification for steel wire ropes for general engineering purposes
IS 2365	Specification for steel wire suspension ropes for lifts, elevators and hoists
ISO 2408:2017	Steel Wire Ropes – Requirements
ISO 2232:1990	Round Drawn Wire for General Purpose non-alloy steel wire ropes and for large diameter steel wire ropes - Specifications
IS 2721	Specification for galvanized steel wire chain link fences fabric
ISO 3108	Steel wire ropes for general purposes – determination of actual breaking load
ISO 4345	Steel wire ropes – Fiber min cores – Specification
ISO 4346	Steel wire ropes for general purposes – lubricants –Basic Requirements

IS 6594	Specification for technical supply condition for wire ropes and strands
ISO 6892-1	Metallic materials – Tensile Testing – Part 1: Method of Test at room temperature
ISO 7800	Metallic materials – Wire – simple torsion test
ISO 17893	Steel wire ropes – Vocabulary, Designation & Classification
IS 12776	Specification for galvanized strand for earthing

6.5.2.21. Road and Paving Materials

PART-1 Standard Specifications and Standard Practices

(a) Aggregates (AASHTO)

Std:/Spec: No.	Title
M 6-13	Fine Aggregate for Hydraulic Cement Concrete
M 17-11 (2015)	Mineral Filler for Bituminous Paving Mixtures
M 29-12	Fine Aggregate for Bituminous Paving Mixtures
M 43-05 (2013)	Sizes of Aggregate for Road and Bridge Construction
M 45-15	Aggregate for Masonry Mortar
M 80-13	Coarse Aggregate for Hydraulic Cement Concrete
M 195-11 (2015)	Concrete Lightweight Aggregates for Structural Concrete
M 327-11 (2015)	Processing Additions for Use in the Manufacture of Hydraulic Cements

(b) Bituminous Materials (AASHTO)

Std:/Spec: No.	Title
M20-70	Standard Specification for Penetration Graded Asphalt Cement
M 81-92 (2012)	Cutback Asphalt (Rapid-Curing Type)
M 82-75 (2012)	Cutback Asphalt (Medium-Curing Type)
M 140-13	Emulsified Asphalt
M 156-13	Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
M 208-01(2013)	Cationic Emulsified Asphalt
M 226-80 (2012)	Viscosity-Graded Asphalt Cement
M 303-89 (2014)	Lime for Asphalt Mixtures
M 316-13	Polymer-Modified Cationic Emulsified Asphalt
M 320-10 (2015)	Performance-Graded Asphalt Binder
M 323-13	Superpave Volumetric Mix Design
M 325-08 (2012)	Stone Matrix Asphalt (SMA)
M 332-14	Performance-Graded Asphalt Binder Using Multiple Stress Creep Recovery (MSCR) Test
R 5-13	Selection and Use of Emulsified Asphalts
R 15-00 (2012)	Asphalt Additives and Modifiers
R 26-01 (2013)	Certifying Suppliers of Performance-Graded Asphalt Binders
R 28-12	Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel (PAV)
R 29-15	Grading or Verifying the Performance Grade (PG) of an

	Asphalt Binder
R 30-02 (2015)	Mixture Conditioning of Hot Mix Asphalt (HMA)
R 35-15	Superpave Volumetric Design for Asphalt Mixtures
R 46-08 (2012)	Designing Stone Matrix Asphalt (SMA)
R 47-14	Reducing Samples of Hot Mix Asphalt (HMA) to Testing Size
R 49-09 (2013)	Determination of Low-Temperature Performance Grade (PG) of Asphalt Binders
R 59-11 (2015)	Recovery of Asphalt Binder from Solution by Abson Method
R 62-13	Developing Dynamic Modulus Master Curves for Asphalt Mixtures
R 66-15	Sampling Asphalt Materials
R 67-15	Sampling Asphalt Mixtures after Compaction (Obtaining Cores)
R 68-15	Preparation of Asphalt Mixtures by Means of the Marshall Apparatus

(c) Box Culvert, Culvert Pipe and Drain Tile (AASHTO)

Std:/Spec: No.	**Title**
M 36-14	Corrugated Steel Pipe, Metallic Coated, for Sewers and Drains
M 86M/M 86-15	Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
M 167M/M 167-14	Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
M 170-15	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
M 170M-15	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe [Metric]
M 175M/M 175-05 (2013)	Perforated Concrete Pipe
M 176M/M 176-07 (2012)	Porous Concrete Pipe
M 178M/M 178-07 (2012)	Concrete Drain Tile
M 190-04 (2012)	Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
M 196-92 (2012)	Corrugated Aluminum Pipe for Sewers and Drains
M 197-06 (2011)	Aluminum Alloy Sheet for Corrugated Aluminum Pipe
M 199M/M 199-14	Precast Reinforced Concrete Manhole Sections
M 206M/M 206-15	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
M 207M/M 207-15	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
M 218-03 (2011)	Steel Sheet, Zinc-Coated (Galvanized), for Corrugated Steel Pipe
M 219-92 (2012)	Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
M 242M/M 242-15	Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
M 243-96 (2012)	Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
M 245-00 (2012)	Corrugated Steel Pipe, Polymer-Precoated, for Sewers and

	Drains
M 246-15	Steel Sheet, Metallic-Coated and Polymer-Precoated, for Corrugated Steel Pipe
M 252-09(2012)	Corrugated Polyethylene Drainage Pipe
M 259-11 (2015)	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
M 259M-11 (2015)	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers [Metric]
M 262-11 (2015)	Concrete Pipe and Related Products
M 273-11 (2015)	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 ft of Cover Subjected to Highway Loadings
M 273M-11 (2015)	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 0.6 m of Cover Subjected to Highway Loadings [Metric]
M 274-87(2012)	Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe
M 278-15	Class PS46 Poly Vinyl Chloride (PVC) Pipe
M 289-91(2012)	Aluminum-Zinc Alloy Coated Sheet Steel for Corrugated Steel Pipe
M 294-15	Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
M 304-11 (2015)	Poly (Vinyl Chloride) (PVC) Profile Wall Drainpipe and Fittings Based on Controlled Inside Diameter
M 306-10 (2015)	Drainage, Sewer, Utility, and Related Castings
M 326-08 (2012)	Polyethylene (PE) Liner Pipe, 300- to 1600-mm Diameter, Based on Controlled Outside Diameter
M 330-13	Polypropylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
R 63-13	Solid Wall High-Density Polyethylene (HDPE) Conduit for Non-Pressure Applications Used for the Protection of Power and Telecommunications Cables

(d) Concrete, Curing Materials and Admixtures (AASHTO)

Std:/Spec: No.	**Title**
M 154M/M 154-12	Air-Entraining Admixtures for Concrete
M 157-13	Ready-Mixed Concrete
M 182-05 (2012)	Burlap Cloth Made from Jute or Kenaf and Cotton Mats
M 194M/M 194-13	Chemical Admixtures for Concrete
M 205M/M 205-11 (2015)	Molds for Forming Concrete Test Cylinders Vertically
M 210M/M 210-14	Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete
M 224-91(2014)	Use of Protective Sealers for Portland Cement Concrete
M 233-86(2014)	Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete
M 241M/M 241-13	Concrete Made by Volumetric Batching and Continuous Mixing

M 295-11 (2015)	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
M 302-15	Slag Cement for Use in Concrete and Mortars
R 39-07 (2012)	Making and Curing Concrete Test Specimens in the Laboratory
R 60-12	Sampling Freshly Mixed Concrete
R 64-15	Sampling and Fabrication of 50-mm (2-in.) Cube Specimens Using Grout (Non-Shrink) or Mortar

(e) Environmental Tests (AASHTO)

Std:/Spec: No.	**Title**
R 23-99 (2013)	Chemical, Biological, and Physical Analysis of Water
R 24-99 (2013)	Collection and Preservation of Water Samples

(f) Guardrails and Fencing (AASHTO)

Std:/Spec: No.	**Title**
M 180-12	Corrugated Sheet Steel Beams for Highway Guardrail
M 181-10 (2015)	Chain-Link Fence
M 269-96(2013)	Turnbuckles and Shackles
M 279-14	Metallic-Coated, Steel Woven Wire Fence Fabric
M 280-14	Metallic-Coated (Carbon) Steel Barbed Wire
M 281-96(2013)	Steel Fence Posts and Assemblies, Hot-Wrought

(g) Hydraulic Cement (AASHTO)

Std:/Spec: No.	**Title**
M 85-15	Portland Cement
M 240M/M 240-15	Blended Hydraulic Cement
M 307-13	Silica Fume Used in Cementitious Mixtures
M 321-04(2012)	High-Reactivity Pozzolans for Use in Hydraulic-Cement Concrete, Mortar, and Grout

(h) Joint Filler and Asphalt Plank (AASHTO)

Std:/Spec: No.	**Title**
M 33-99 (2012)	Preformed Expansion Joint Filler for Concrete (Bituminous Type)
M 153-06(2011)	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
M 213-01(2015)	Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non extruding and Resilient Bituminous Types)
M 251-06(2011)	Plain and Laminated Elastomeric Bridge Bearings
M 297-10 (2015)	Preformed Polychloroprene Elastomeric Joint Seals for Bridges
R 50-09 (2013)	Geosynthetic Reinforcement of the Aggregate Base Course of Flexible Pavement Structures

(i) Metallic Materials for Bridges (AASHTO)

Std:/Spec: No.	Title
M 102M/M 102-06 (2011)	Steel Forgings, Carbon and Alloy, for General Industrial Use
M 103M/M 103-12	Steel Castings, Carbon, for General Application
M 105-09 (2013)	Gray Iron Castings
M 111M/M 111-15	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
M 163M/M 163-07 (2012)	Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application
M 169-15	Steel Bars, Carbon and Alloy, Cold-Finished
M 202M/M 202-08 (2012)	Steel Sheet Piling
M 227M/M 227-13	Steel Bars, Carbon, Merchant Quality, Mechanical Properties
M 232M/M 232-10 (2015)	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
M 255M/M 255-05 (2013)	Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
M 270M/M 270-15	Structural Steel for Bridges
M 277-06 (2015)	Wire Rope and Sockets for Movable Bridges
M 285M/M 285-11 (2015)	Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service
M 292M/M 292-15	Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
M 314-90 (2013)	Steel Anchor Bolts
M 333-15	Detectable Warning Surfaces

(j) Miscellaneous (AASHTO)

Std:/Spec: No.	Title
M 143-14	Sodium Chloride
M 144-14	Calcium Chloride
M 230-07(2012)	Expanded and Extruded Foam Board (Polystyrene)
M 235M/M 235-13	Epoxy Resin Adhesives
R 8-96 (2015)	Evaluation of Transportation-Related Earth borne Vibrations
R 10-06 (2011)	Definition of Terms Related to Quality and Statistics as used in Highway Construction
R 16-04 (2009)	Regulatory Information for Chemicals Used in AASHTO Tests
R 25-00 (2013)	Technician Training and Qualification Programs
R 34-03 (2013)	Evaluating Deicing Chemicals
R 44-07 (2012)	Independent Assurance (IA) Programs

(k) Painting and Traffic Marking and Signing (AASHTO)

Std:/Spec: No.	Title
M 237-96 (2014)	Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete
M 247-13	Glass Beads Used in Pavement Markings
M 248-91 (2012)	Ready-Mixed White and Yellow Traffic Paints
M 249-12	White and Yellow Reflective Thermoplastic Striping Material

	(Solid Form)
M 268-15	Retroreflective Sheeting for Flat and Vertical Traffic Control Applications
M 290-96 (2013)	Acrylic Prismatic Reflectors and Embossed Aluminum Frames for Signs
M 300-03 (2012)	Inorganic Zinc-Rich Primer
R 31-09 (2014)	Evaluation of Protective Coating Systems for Structural Steel

(l) Pavement Surface Characteristics (AASHTO)

Std:/Spec: No.	**Title**
M 328-14	Inertial Profiler
M 331-13	Smoothness of Pavement in Weigh-in-Motion (WIM) Systems
R 36-13	Evaluating Faulting of Concrete Pavements
R 37-04 (2013)	Application of Ground Penetrating Radar (GPR) to Highways
R 40-10 (2013)	Measuring Pavement Profile Using a Rod and Level
R 41-05 (2015)	Measuring Pavement Profile Using a Dipstick®
R 43-13	Quantifying Roughness of Pavements
R 48-10 (2013)	Determining Rut Depth in Pavements
R 54-14	Accepting Pavement Ride Quality When Measured Using Inertial Profiling Systems
R 55-10 (2013)	Quantifying Cracks in Asphalt Pavement Surfaces
R 56-14	Certification of Inertial Profiling Systems
R 57-14	Operating Inertial Profiling Systems

(m) Quality Assurance (AASHTO)

Std:/Spec: No.	**Title**
R 9-05 (2013)	Acceptance Sampling Plans for Highway Construction
R 18-10 (2015)	Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
R 20-99 (2012)	Procedures for Measuring Highway Noise
R 38-10 (2013)	Quality Assurance of Standard Manufactured Materials
R 42-06 (2011)	Developing a Quality Assurance Plan for Hot Mix Asphalt (HMA)
R 61-12	Establishing Requirements for Equipment Calibrations, Standardizations, and Checks
R 65-14	Evaluating the Engineering and Environmental Suitability of Recycled Materials

(n) Reinforcing Steel and Wire Rope (AASHTO)

Std:/Spec: No.	**Title**
M 30-15	Zinc-Coated Steel Wire Rope and Fittings for Highway Guardrail
M 31M/M 31-15	Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
M 32M/M 32-09 (2013)	Steel Wire, Plain, for Concrete Reinforcement
M 54M/M 54-07 (2012)	Welded Deformed Steel Bar Mats for Concrete Reinforcement

M 55M/M 55-09 (2013)	Steel Welded Wire Reinforcement, Plain, for Concrete
M 203M/M 203-12	Steel Strand, Uncoated Seven-Wire for Concrete Reinforcement
M 204M/M 204-14	Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
M 221M/M 221-09 (2013)	Steel Welded Wire Reinforcement, Deformed, for Concrete
M 225M/M 225-09 (2013)	Steel Wire, Deformed, for Concrete Reinforcement
M 254-06 (2015)	Corrosion-Resistant Coated Dowel Bars
M 275M/M 275-08 (2012)	Uncoated High-Strength Steel Bars for Prestressing Concrete
M 322M/M 322-10 (2015)	Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
M 329M/M 329-11 (2015)	Stainless Clad Deformed and Plain Round Steel Bars for Concrete Reinforcement

(o) Soil and Stabilization (AASHTO)

Std:/Spec: No.	**Title**
M 57-80 (2012)	Materials for Embankments and Subgrades
M 145-91 (2012)	Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
M 146-91 (2012)	Terms Relating to Subgrade, Soil-Aggregate, and Fill Materials
M 147-65 (2012)	Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses
M 216-13	Lime for Soil Stabilization
M 288-15	Geotextile Specification for Highway Applications
M 318-02 (2015)	Glass Cullet Use for Soil-Aggregate Base Course
M 319-02 (2015)	Reclaimed Concrete Aggregate for Unbound Soil-Aggregate Base Course
R 13-12	Conducting Geotechnical Subsurface Investigations
R 21-96 (2015)	Drilling for Subsurface Investigations—Unexpectedly Encountering Suspected Hazardous Material
R 22-97 (2015)	Decommissioning Geotechnical Exploratory Boreholes
R 27-01 (2010)	Assessment of Corrosion of Steel Piling for Non-Marine Applications
R 51-13	Compost for Erosion/Sediment Control (Filter Berms and Filter Socks)
R 52-10 (2015)	Compost for Erosion/Sediment Control (Compost Blankets)
R 58-11 (2015)	Dry Preparation of Disturbed Soil and Soil-Aggregate Samples for Test
R 69-15	Determination of Long-Term Strength for Geosynthetic Reinforcement

(p) Testing Equipment (AASHTO)

Std:/Spec: No.	**Title**
M 92-10 (2015)	Wire-Cloth Sieves for Testing Purposes
M 152M/M 152-15	Flow Table for Use in Tests of Hydraulic Cement
M 201-15	Mixing Rooms, Moist Cabinets, Moist Rooms, and Water Storage Tanks Used in the Testing of Hydraulic Cements and Concretes

M 231-95 (2015)	Weighing Devices Used in the Testing of Materials
M 261-96 (2013)	Rib-Tread Standard Tire for Special-Purpose Pavement Frictional-Property Tests
M 286-96 (2013)	Smooth-Tread Standard Tire for Special-Purpose Pavement Frictional-Property Tests
R 32-11 (2015)	Calibrating the Load Cell and Deflection Sensors for a Falling Weight Deflectometer
R 33-11 (2015)	Calibrating the Reference Load Cell Used for Reference Calibrations for a Falling Weight Deflectometer
R 45-13	Installing, Monitoring, and Processing Data of the Traveling Type Slope Inclinometer

(q) Timber and Preservatives (AASHTO)

Std:/Spec: No.	**Title**
M 133-12	Preservatives and Pressure Treatment Processes for Timber
M 168-07 (2012)	Wood Products

PART-2 TESTS

(a) Aggregates (AASHTO)

Std:/Spec: No.	**Title**
T 2-91 (2015)	Sampling of Aggregates
T 11-05 (2013)	Materials Finer Than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
T 19M/T 19-14	Bulk Density ("Unit Weight") and Voids in Aggregate
T 21M/T 21-15	Organic Impurities in Fine Aggregates for Concrete
T 27-14	Sieve Analysis of Fine and Coarse Aggregates
T 30-15	Mechanical Analysis of Extracted Aggregate
T 37-07 (2011)	Sieve Analysis of Mineral Filler for Hot Mix Asphalt (HMA)
T 71-08 (2012)	Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
T 84-13	Specific Gravity and Absorption of Fine Aggregate
T 85-14	Specific Gravity and Absorption of Coarse Aggregate
T 96-02 (2015)	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
T 104-99 (2011)	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
T 112-00 (2012)	Clay Lumps and Friable Particles in Aggregate
T 113-15	Lightweight Pieces in Aggregate
T 210-15	Aggregate Durability Index
T 248-14	Reducing Samples of Aggregate to Testing Size
T 255-00 (2012)	Total Evaporable Moisture Content of Aggregate by Drying
T 279-14	Accelerated Polishing of Aggregates Using the British Wheel
T 304-11 (2015)	Uncompacted Void Content of Fine Aggregate
T 326-05 (2013)	Uncompacted Void Content of Coarse Aggregate (As

	Influenced by Particle Shape, Surface Texture, and Grading)
T 327-12	Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
T 330-07 (2015)	The Qualitative Detection of Harmful Clays of the Smectite Group in Aggregates Using Methylene Blue
T 335-09 (2013)	Determining the Percentage of Fracture in Coarse Aggregate
T 354-15	Specific Gravity and Absorption of Aggregate by Volumetric Immersion Method

(b) Bituminous Materials (AASHTO)

Std:/Spec: No.	**Title**
T 44-14	Solubility of Bituminous Materials
T 48-06 (2015)	Flash and Fire Points by Cleveland Open Cup
T 49-15	Penetration of Bituminous Materials
T 50-14	Float Test for Bituminous Materials
T 51-09 (2013)	Ductility of Asphalt Materials
T 53-09 (2013)	Softening Point of Bitumen (Ring-and-Ball Apparatus)
T 59-15	Emulsified Asphalts
T 72-10 (2015)	Saybolt Viscosity
T 78-15	Distillation of Cutback Asphalt Products
T 79-12	Flash Point with Tag Open-Cup Apparatus for Use with Material Having a Flash Point Less Than 93ºC (200ºF)
T 102-09 (2013)	Spot Test of Asphaltic Materials
T 110-03 (2011)	Moisture or Volatile Distillates in Hot Mix Asphalt (HMA)
T 111-11 (2015)	Mineral Matter or Ash in Asphalt Materials
T 164-14	Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA)
T 166-13	Bulk Specific Gravity of Compacted (Gmb) Hot Mix Asphalt (HMA) Using Saturated Surface Dry Specimens
T 167-10 (2015)	Compressive Strength of Hot Mix Asphalt
T 168-03 (2011)	Sampling Bituminous Paving Mixtures
T 179-05 (2013)	Effect of Heat and Air on Asphalt Materials (Thin-Film Oven Test)
T 195-11 (2015)	Determining Degree of Particle Coating of Asphalt Mixtures
T 201-15	Kinematic Viscosity of Asphalts (Bitumens)
T 202-15	Viscosity of Asphalts by Vacuum Capillary Viscometer
T 209-12	Theoretical Maximum Specific Gravity (Gmm) and Density of Hot Mix Asphalt (HMA)
T 228-09 (2013)	Specific Gravity of Semi-Solid Asphalt Materials
T 240-13	Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
T 245-15	Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus
T 246-10 (2015)	Resistance to Deformation and Cohesion of Hot Mix Asphalt (HMA)by Means of Hveem Apparatus
T 247-10 (2015)	Preparation of Test Specimens of Hot Mix Asphalt (HMA) by

	Means of California Kneading Compactor
T 269-14	Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
T 275-07 (2012)	Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Paraffin-Coated Specimens
T 283-14	Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage
T 287-14	Asphalt Binder Content of Asphalt Mixtures by the Nuclear Method
T 295-13	Specific Gravity or API Gravity of Liquid Asphalts by Hydrometer Method
T 300-11	Force Ductility Test of Asphalt Materials
T 301-13	Elastic Recovery Test of Asphalt Materials by Means of a Ductilimeter
T 302-15	Polymer Content of Polymer-Modified Emulsified Asphalt Residue and Asphalt Binders
T 305-14	Determination of Drain down Characteristics in Uncompacted Asphalt Mixtures
T 308-10 (2015)	Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method
T 309-15	Temperature of Freshly Mixed Portland Cement Concrete
T 312-15	Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor
T 313-12	Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
T 314-12	Determining the Fracture Properties of Asphalt Binder in Direct Tension (DT)
T 315-12	Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
T 316-13	Viscosity Determination of Asphalt Binder Using Rotational Viscometer
T 319-15	Quantitative Extraction and Recovery of Asphalt Binder from Asphalt Mixtures
T 320-07 (2011)	Determining the Permanent Shear Strain and Stiffness of Asphalt Mixtures Using the Superpave Shear Tester (SST)
T 321-14	Determining the Fatigue Life of Compacted Asphalt Mixtures Subjected to Repeated Flexural Bending
T 322-07 (2011)	Determining the Creep Compliance and Strength of Hot Mix Asphalt (HMA) Using the Indirect Tensile Test Device
T 324-14	Hamburg Wheel-Track Testing of Compacted Hot Mix Asphalt (HMA)
T 329-13	Moisture Content of Hot Mix Asphalt (HMA) by Oven Method
T 331-13	Bulk Specific Gravity (Gmb) and Density of Compacted Hot Mix Asphalt (HMA) Using Automatic Vacuum Sealing Method
T 340-10 (2015)	Determining Rutting Susceptibility of Hot Mix Asphalt (HMA) Using the Asphalt Pavement Analyzer (APA)

T 342-11 (2015)	Determining Dynamic Modulus of Hot Mix Asphalt (HMA)
T 343-12	Density of In-Place Hot Mix Asphalt (HMA) Pavement by Electronic Surface Contact Devices
T 344-12	Evaluation of Superpave Gyratory Compactor (SGC) Internal Angle of Gyration Using Simulated Loading
T 350-14	Multiple Stress Creep Recover (MSCR) Test of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
T 355-15	In-Place Density of Asphalt Mixtures by Nuclear Methods

(c) Box Culvert, Culvert Pipe and Drain Tile (AASHTO)

Std:/Spec: No.	**Title**
T 241-95 (2012)	Helical Continuously Welded Seam Corrugated Steel Pipe
T 249-03 (2011)	Helical Lock Seam Corrugated Pipe
T 280-14	Concrete Pipe, Manhole Sections, or Tile
T 281-14	Vitrified Clay Pipe
T 341-10 (2014)	Determination of Compression Capacity for Profile Wall Plastic Pipe by Stub Compression Loading

(d) Concrete, Curing Materials and Admixtures (AASHTO)

Std:/Spec: No.	**Title**
T 22-14	Compressive Strength of Cylindrical Concrete Specimens
T 23-14	Making and Curing Concrete Test Specimens in the Field
T 24M/T 24-15	Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
T 97-14	Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
T 119M/T 119-13	Slump of Hydraulic Cement Concrete
T 121M/T 121-15	Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
T 140-97 (2011)	Compressive Strength of Concrete Using Portions of Beams Broken in Flexure
T 148-15	Measuring Length of Drilled Concrete Cores
T 152-13	Air Content of Freshly Mixed Concrete by the Pressure Method
T 155-13	Water Retention by Liquid Membrane-Forming Curing Compounds for Concrete
T 157-12	Air-Entraining Admixtures for Concrete
T 158-11 (2015)	Bleeding of Concrete
T 160-09 (2014)	Length Change of Hardened Hydraulic Cement Mortar and Concrete
T 161-08 (2012)	Resistance of Concrete to Rapid Freezing and Thawing
T 177-10 (2015)	Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)
T 178-15	Portland-Cement Content of Hardened Hydraulic-Cement Concrete
T 196M/T 196-11 (2015)	Air Content of Freshly Mixed Concrete by the Volumetric Method

T 197M/T 197-11 (2015)	Time of Setting of Concrete Mixtures by Penetration Resistance
T 198-15	Splitting Tensile Strength of Cylindrical Concrete Specimens
T 231-13	Capping Cylindrical Concrete Specimens
T 253-02 (2011)	Coated Dowel Bars
T 259-02 (2012)	Resistance of Concrete to Chloride Ion Penetration
T 260-97 (2011)	Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials
T 276-15	Measuring Early-Age Compression Strength and Projecting Later-Age Strength
T 277-15	Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
T 285-89 (2015)	Bend Test for Bars for Concrete Reinforcement
T 303-00 (2012)	Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction
T 318-15	Water Content of Freshly Mixed Concrete Using Microwave Oven Drying
T 325-04 (2011)	Estimating the Strength of Concrete in Transportation Construction by Maturity Tests
T 332-07 (2011)	Determining Chloride Ions in Concrete and Concrete Materials by Specific Ion Probe
T 334-08 (2012)	Estimating the Cracking Tendency of Concrete
T 336-15	Coefficient of Thermal Expansion of Hydraulic Cement Concrete
T 345-12	Passing Ability of Self-Consolidating Concrete (SCC) by J-Ring
T 347-13	Slump Flow of Self-Consolidating Concrete (SCC)
T 348-13	Air-Void Characteristics of Freshly Mixed Concrete by Buoyancy Change
T 349-13	Filling Capacity of Self-Consolidating Concrete Using the Caisson Test
T 351-14	Visual Stability Index (VSI) of Self-Consolidating Concrete (SCC)
T 352-14	Determining Formwork Pressure of Fresh Self-Consolidating Concrete (SCC) Using Pressure Transducers
T 356-15	Determining Air Content of Hardened Portland Cement Concrete by High-Pressure Air Meter
T 357-15	Predicting Chloride Penetration of Hydraulic Cement Concrete by the Rapid Migration Procedure
T 358-15	Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration

(e) Hydraulic Cement (AASHTO)

Std:/Spec: No.	**Title**
T 98-12	Fineness of Portland Cement by the Turbidimeter
T 105-14	Chemical Analysis of Hydraulic Cement
T 106M/T 106-15	Compressive Strength of Hydraulic Cement Mortar (Using 50-

	mm or 2-in. Cube Specimens)
T 107M/T 107-11 (2015)	Autoclave Expansion of Hydraulic Cement
T 127-15	Sampling and Amount of Testing of Hydraulic Cement
T 129-14	Amount of Water Required for Normal Consistency of Hydraulic Cement Paste
T 131-15	Time of Setting of Hydraulic Cement by Vicat Needle
T 132-87 (2013)	Tensile Strength of Hydraulic Cement Mortars
T 133-11 (2015)	Density of Hydraulic Cement
T 137-12	Air Content of Hydraulic Cement Mortar
T 153-13	Fineness of Hydraulic Cement by Air Permeability Apparatus
T 154-15	Time of Setting of Hydraulic Cement by Gillmore Needles
T 162-15	Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
T 185-15	Early Stiffening of Hydraulic Cement (Mortar Method)
T 186-15	Early Stiffening of Hydraulic Cement (Paste Method)
T 188-05 (2012)	Evaluation by Freezing and Thawing of Air-Entraining Additions to Hydraulic Cement
T 192-11 (2015)	Fineness of Hydraulic Cement by the 45-μm (No. 325) Sieve
T 323-03 (2011)	Determining the Shear Strength at the Interface of Bonded Layers of Portland Cement Concrete
T 353-14	Particle Size Analysis of Hydraulic Cement and Related Materials by Light Scattering

(f) Joint Filler and Asphalt Plank (AASHTO)

Std:/Spec: No.	**Title**
T 42-10 (2015)	Preformed Expansion Joint Filler for Concrete Construction

(g) Metallic Materials for Bridges (AASHTO)

Std:/Spec: No.	**Title**
T 65M/T 65-13	Mass [Weight] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
T 213M/T 213-11 (2015)	Mass [Weight] of Coating on Aluminum-Coated Iron or Steel Articles
T 243M/T 243-08 (2012)	Sample Procedure for Impact Testing of Structural Steel
T 244-14	Mechanical Testing of Steel Products
T 337-09 (2014)	Non-Instrumental Determination of Metallic Zinc in Zinc-Rich Primers
T 338-09 (2014)	Analysis of Structural Steel Coatings for Hindered Amine Light Stabilizer (HALS)
T 339-10 (2015)	Analysis of Structural Steel Coatings for Isocyanate Content

(h) Miscellaneous (AASHTO)

Std:/Spec: No.	**Title**
T 256-01 (2011)	Pavement Deflection Measurements
T 257-96 (2013)	Instrumental Photometric Measurements of Retroreflective Materials and Retroreflective Devices

(i) Painting and Traffic Marking and Signing (AASHTO)

Std:/Spec: No.	Title
T 143-13	Sampling and Testing Calcium Chloride for Roads and Structural Applications
T 237-05 (2014)	Testing Epoxy Resin Adhesive
T 250-05 (2014)	Thermoplastic Traffic Line Material
T 333-07 (2012)	Linear Coefficient of Shrinkage on Cure of Adhesive Systems
T 346-13	Glass Beads Used in Pavement Markings

(j) Pavement Surface Characteristics (AASHTO)

Std:/Spec: No.	Title
T 242-96 (2014)	Frictional Properties of Paved Surfaces Using a Full-Scale Tire
T 278-90 (2012)	Surface Frictional Properties Using the British Pendulum Tester
T 282-01 (2015)	Calibrating a Wheel Force or Torque Transducer Using a Calibration Platform (User Level)
T 317-04 (2014)	Prediction of Asphalt-Bound Pavement Layer Temperatures

(k) Soils and Stabilization (AASHTO)

Std:/Spec: No.	Title
T 88-13	Particle Size Analysis of Soils
T 89-13	Determining the Liquid Limit of Soils
T 90-15	Determining the Plastic Limit and Plasticity Index of Soils
T 99-15	Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
T 100-15	Specific Gravity of Soils
T 134-05 (2013)	Moisture-Density Relations of Soil-Cement Mixtures
T 135-13	Wetting-and-Drying Test of Compacted Soil-Cement Mixtures
T 136-13	Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures
T 146-96 (2013)	Wet Preparation of Disturbed Soil Samples for Test
T 176-08 (2013)	Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
T 180-15	Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
T 190-14	Resistance R-Value and Expansion Pressure of Compacted Soils
T 191-14	Density of Soil In-Place by the Sand-Cone Method
T 193-13	The California Bearing Ratio
T 194-97 (2013)	Determination of Organic Matter in Soils by Wet Combustion
T 206-09 (2013)	Penetration Test and Split-Barrel Sampling of Soils
T 207-12	Thin-Walled Tube Sampling of Soils
T 208-10	Unconfined Compressive Strength of Cohesive Soil
T 211-90 (2012)	Determination of Cement Content in Cement-Treated Aggregate by the Method of Titration
T 215-14	Permeability of Granular Soils (Constant Head)
T 216-07 (2012)	One-Dimensional Consolidation Properties of Soils

T 217-14	Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester
T 218-86 (2013)	Sampling Hydrated Lime
T 219-87 (2013)	Testing Lime for Chemical Constituents and Particle Sizes
T 220-66 (2013)	Determination of the Strength of Soil-Lime Mixtures
T 221-90 (2012)	Repetitive Static Plate Load Tests of Soils and Flexible Pavement Components for Use in Evaluation and Design of Airport and Highway Pavements
T 222-81 (2012)	Nonrepetitive Static Plate Load Test of Soils and Flexible Pavement Components for Use in Evaluation and Design of Airport and Highway Pavements
T 223-96 (2012)	Field Vane Shear Test in Cohesive Soil
T 224-10	Discontinued—Correction for Coarse Particles in the Soil Compaction Test
T 225-06 (2015)	Diamond Core Drilling for Site Investigation
T 226-90 (2013)	Triaxial Compressive Strength of Undrained Rock Core Specimens without Pore Pressure Measurements
T 232-90 (2013)	Determination of Lime Content in Lime-Treated Soils by Titration
T 233-02 (2015)	Density of Soil In-Place by Block, Chunk, or Core Sampling
T 236-08 (2013)	Direct Shear Test of Soils under Consolidated Drained Conditions
T 252-09 (2013)	Measurements of Pore Pressures in Soils
T 258-81 (2013)	Determining Expansive Soils
T 265-15	Laboratory Determination of Moisture Content of Soils
T 267-86 (2013)	Determination of Organic Content in Soils by Loss on Ignition
T 272-10	Family of Curves—One-Point Method
T 273-86 (2013)	Soil Suction
T 288-12	Determining Minimum Laboratory Soil Resistivity
T 289-91 (2013)	Determining pH of Soil for Use in Corrosion Testing
T 290-95 (2012)	Determining Water-Soluble Sulfate Ion Content in Soil
T 291-94 (2013)	Determining Water-Soluble Chloride Ion Content in Soil
T 296-10	Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression
T 297-94 (2012)	Consolidated, Undrained Triaxial Compression Test on Cohesive Soils
T 298-15	High-Strain Dynamic Testing of Piles
T 306-11 (2015)	Progressing Auger Borings for Geotechnical Explorations
T 307-99 (2012)	Determining the Resilient Modulus of Soils and Aggregate Materials
T 310-13	In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
T 311-00 (2015)	Grain-Size Analysis of Granular Soil Materials

6.5.2.22. Smart Cities

Std No.	Title
ISO 37100:2016	Sustainable Cities and Communities — Vocabulary
ISO 37101:2016	Sustainable Development in Communities — Management System for Sustainable Development — Requirements with Guidance for Use
ISO 37104:2019	Sustainable Cities and Communities — Transforming Our Cities — Guidance for Practical Local Implementation of ISO 37101
ISO 37120:2018	Sustainable Cities and Communities — Indicators for City Services and Quality of Life
ISO 37122:2019	Sustainable Cities and Communities — Indicators for Smart Cities
ISO 37123:2019	Sustainable Cities and Communities — Indicators for Resilient Cities
ISO/TS 37151:2015	Smart Community Infrastructures — Principles and Requirements for Performance met
ISO/TR 37152:2016	Smart Community Infrastructures — Common Framework for Development and Operation

MNBC -2025 TECHNICAL WORKING GROUP (TWG-6)

Participants List

1.	U San Kyu	Group Leader
2.	U Wai Yar Aung	Secretary
3.	Daw Aye Aye Maw	Member
4.	U Win Naing Tun	Member
5.	Daw Thandar Win	Member
6.	Daw Khine Nyein Soe	Member
7.	Daw Mya Myet Chael	Member
8.	U Phone Kyaw	Member
9.	U Kyaw Kyaw Latt	Member
10.	U Min Min	Member
11.	Daw Nyein Nyein Htway	Member
12.	U Tint Zaw Nyunt	Member
13.	U Si Thu Aye Ko	Member
14.	U Win Naing	Member
15.	U Saw Pyae Aung	Member
16.	Dr. Khin Su Su Htwe	Member
17.	Dr. Khin Than Thin/	Member
18.	Dr. Kay Thi Lwin	Member
19.	Dr. Mya Mya Than	Member
20.	Daw Wint Moh Aung	Member
21.	Daw Zin Zin Hlaing	Member
22.	U Ayar Moe	Member
23.	Daw Myat Thu Zar	Member
24.	U Htain Lin Oo	Member
25.	U Naing Aung Linn	Member
26.	U Win Htun	Member

MYANMAR NATIONAL BUILDING CODE 2025

PART 7

CONSTRUCTION MANAGEMENT AND PLANNING, CONSTRUCTION PRACTICES, SAFETY AND BUILDING MAINTENANCE

This Part of the Code covers the construction management, planning, site management and practices in buildings; storage, stacking and handling of materials and safety of personnel during construction operations for all elements of a building and demolition of buildings

MYANMAR NATIONAL BUILDING CODE - 2025

PART – 7 CONSTRUCTION MANAGEMENT AND PLANNING, CONSTRUCTION PRACTICES, SAFETY AND BUILDING MAINTENANCE

CONTENTS

7.1 CONSTRUCTION MANAGEMENT, PLANNING AND SITE MANAGEMENT

7.1.1 CONSTRUCTION PROJECT MANAGEMENT

7.1.1.1 A project is generally a non-recurring task having a definable beginning and end, with a definite mission and has a set of objectives and achievements. Project management is application of knowledge, skills, tools and techniques to achieve the objectives of a defined project with the aim to ensure that a project is completed within the scheduled time, authorized cost and to the requirement of quality standards. Construction project management refers to such project management when applied to construction of built facility. Project objectives depend on the requirements of the built facility. From the point of view of construction project management, project objectives may be defined in terms of scope, time, cost and quality. This may usually take place in project appraisal stage and shall be done in accordance with the **Suffix [7(1)]**. Information and guidelines given under 7.1.1.2 to 7.1.1.6 shall be appropriately utilized under different stages of construction project.

7.1.1.2 Stakeholder

Stakeholder is a person, group of persons or organizations who are actively involved in the project or those who have an interest in the success of a project and its environment. Generally, in a construction project, besides the owner/client, the project manager, consultants, construction agencies and the users are the stakeholders. In addition, depending on the nature of the project, there may be other stakeholders such as financer, government and public at large.

7.1.1.3 Construction Project Life Cycle

Construction project life cycle consists of project formulation and appraisal, project development, planning for construction, tender action, construction, and commissioning and handing over, as main stages. These stages involve defined decisions, deliverables and completion of mile-stones for control of project, ensuring that the adverse impact of uncertainties is overcome at each stage in the progress. Accordingly, the responsibilities of project team should be defined and measured for acceptance, and liabilities determined objectively.

Project objectives, drawn out of feasibility established in the appraisal stage, are achieved progressively through each of the project life cycle stages. The stagewise break-up of project objectives, tasks, compliance and authorization to proceed further in the next stage should be structured comprehensively through various stages of life cycle. Each stage of construction project life cycle may be considered as a subproject, thus making overall complexities of a project more manageable.

A typical construction project life cycle is given in Fig. 1.

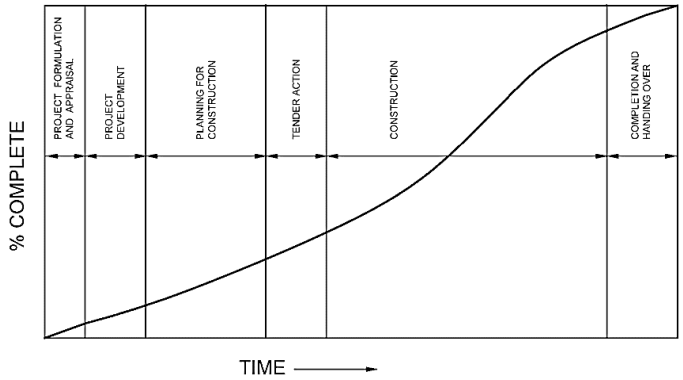


FIG. 1 TYPICAL CONSTRUCTION PROJECT LIFE CYCLE

7.1.1.4 Construction Project Delivery Models

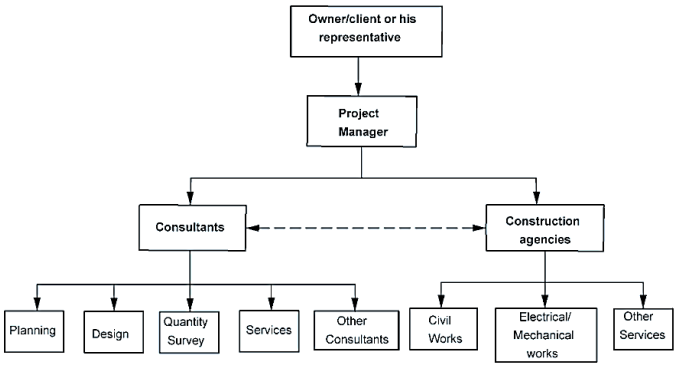
Project delivery model determines the manner in which the project is planned, designed, executed and contract administration carried out. It also determines the contractual relationships between the owner/client, design consultants and construction agency. The delivery model shall define the span of control and role and responsibilities of each of the above parties. The main types of project delivery models that are in vogue in construction projects are: (a) Traditional design-bid build, (b) Design-build with variants, (c) Turn-key and (d) Build, operate and transfer and its variants. Each of the delivery models can adopt different types of contracts depending upon the suitability of the contract type in relation to the nature and type of projects, project objectives and other project specific considerations.

7.1.1.5 Construction Methodologies and Techniques

Suitable construction methodologies and techniques, such as, conventional, prefabrication, systems building approach, mixed/composite construction, mechanization in construction and other innovative technologies, shall be defined considering design principles adopted and also considering the project objectives in terms of factors, like, scope, time, cost and quality requirements. Method statement may be made for all critical items of work.

7.1.1.6 Organizational Structures

Organizational structure depends on the project delivery model. As an example, a typical organization chart for Design-Bid-Build model is given in Fig. 2.



NOTE — 'Consultants' may cover in-house teams or outside consultants.

FIG. 2 TYPICAL ORGANIZATION STRUCTURE FOR DESIGN-BID-BUILD MODEL

7.1.1.6.1 Construction project management organizational teams

For any given project delivery model, an appropriate organizational structure shall be selected so as to facilitate constitution of teams across various agencies involved. Such teams are fundamental functional units generally specific to each of the life cycle stages of a project. Health, Safety and Environment (HSE) and quality set up shall directly report to the Project Manager.

7.1.2 STAGES OF A CONSTRUCTION PROJECT

7.1.2.1 Typically a construction project (whether small or large) may be considered to involve the following distinct broad stages:

a) Project formulation and appraisal stage:

1) Inception,

2) Feasibility, and

3) Strategic planning.

b) Pre-construction stage:

1) Project development,

2) Planning for construction, and

3) Tender action.

c) Construction stage, and

d) Commissioning and handing over stage.

7.1.2.2 Project Formulation and Appraisal Stage

For successful management of construction projects, the earlier stages when the construction project is conceived, formulated and its feasibility assessed, leading to decision to implement the project, are equally important. The guidelines given in the **Suffix [7(1)]** should be employed during project formulation and appraisal stage of a construction project.

NOTE -This stage of a construction project is basically the preliminary stage covering activities up to the stage of preparation of proposals for obtaining approval for implementing the project including financial approval and includes inception, pre-feasibility, feasibility, related project strategic planning and viability assessment and review prior to approval of project.

For all other above stages, the relevant construction management function guidelines given in 7.1.3 should be employed for achieving the intended objectives.

7.1.2.3 Pre-Construction

7.1.2.3.1 Project development

This shall involve the following:

a) Formalization of design brief;

b) Site survey and soil investigation;

c) Hazard risk vulnerability analysis;

d) Alternative concept designs with costing and finalization;

e) Preliminary designs and drawings;

f) Development of design of each discipline and their integration;

g) Obtaining statutory approvals;

h) Selection of construction methodology;

i) Preliminary cost estimates;

j) Detailed planning and design of each discipline;

k) Construction working drawings and related specifications with integration of engineering inputs of all concerned disciplines;

l) Detailed cost estimates;

m) Detailed specifications and bills of quantities; and

n) Tender documents.

Peer review/proof checking of the drawings/ designs/ estimates shall be done in case of important projects, depending upon their complexity and sensitivity. Environment impact analysis and social impact analysis shall be done in applicable cases.

7.1.2.3.2 Planning for construction

The following aspects shall be considered:

a) Sequencing of project components,

b) Planning tools:

1) Work breakdown structures (WBS),

2) Bar charts, and

3) Network techniques and scheduling.

c) Resource planning, and

d) Time cost trade off.

7.1.2.3.2.1 Sequencing of project components

Methodology of construction shall be detailed before the start of the project. Sequencing of project components shall be done on the basis of methodology adopted and availability of resources. This shall be reviewed during the progress of the project and revised, if necessary.

7.1.2.3.2.2 Planning tools

The planning tools described below may be employed for effective management of a construction project:

a) Work breakdown structure (WBS) – The WBS shall identify the total scope of works involved in the project and shall form the basis for the development of detailed project schedule. Through WBS, the project shall be subdivided into major subdivisions (work packages) and each major subdivision shall be further subdivided into additional levels as required up to the level of activities that could form the basis for monitoring and control of project performance in terms of time, cost and quality parameters. WBS shall provide activity listing with associated cost account codes for the preparation of project schedule either by bar charts or by network diagramming methods.

b) Bar chart - Bar chart is the simplest form of project scheduling and used for small and complex projects and in preliminary planning and tender-stages of major projects. A typical bar chart form of project schedule depicts the various activities on a calendar time scale in the form of bars in their relative positions with start and finish dates and length of bar indicating probable activity duration. Linked bars represent the interdependencies between the activities. Bar chart type of schedule shall be used to comprehend, summarize and display the results of complex project network analysis and further monitoring and controlling process.

c) Network techniques and scheduling

1) Network diagramming methods - Network based project schedule shall be used for major and complex projects. In this method, the network of project activities identified through WBS is developed incorporating their logical relationships and interdependencies. The two available approaches for network diagramming techniques are arrow diagramming method (ADM) and precedence diagramming method (PDM).

2) Network analysis and scheduling – The project network incorporating the activity durations and logical relationships shall be analyzed with forward and backward pass schedule calculations to establish early and late start and finish time of activities with their available floats, critical activities, critical path and overall project duration. The project schedule is prepared in terms of calendar dates of start and finish of activities with available floats. The network schedule shall also be presented in the form of linked bar chart or in tabular format.

For details on network preparation and analysis, reference shall be made to ***Suffix [7(2)].*** *Network schedule shall be prepared for all disciplines and they shall be integrated into a master control schedule.*

7.1.2.3.2.3 Resource planning

This shall involve the following:

a) Resource allocation

The feasibility of the network shall be checked with respect to manpower, equipment, materials, other resources required at the site.

b) Resource levelling

It shall be done by reallocating the slack resources from noncritical path to critical path activity in order to obtain a reduction of time or by shifting the activities within the floats available with them, to obtain optimum uniform resource requirements.

c) Resource schedule

Schedule of following resource requirements with respect to time shall be prepared on the basis of network developed and kept in the database for project control purposes:

1) Technology,
2) Manpower:
   i) Technical staff,
   ii) Skilled labour,
   iii) Unskilled labour,
3) Machinery,
4) Materials, and
5) Cash flow.

Resource schedule shall be prepared separately for client, consultant and construction agency.

7.1.2.3.2.4 Time cost trade off

Time cost trade off analysis shall be done to obtain a minimum total cost of the project within the specified time. This shall be done taking into consideration direct cost and indirect cost of the project.

7.1.2.3.3 Tender action

7.1.2.3.3.1 Preparation of tender documents

The bill of quantities, specifications, drawings and conditions of contract should be prepared on the basis of design and details finalized in project proposal development stage (see 7.1.2.3.1) keeping in view the construction project delivery model selected. The format, terminologies and terms and conditions should be as per the standard engineering practices. In case of any special item or condition, the same shall be described clearly to avoid any ambiguity.

7.1.2.3.3.2 Selection of Construction Agency / Contractor

Selection of construction agency/contractor shall be done by either:

a) **Open competitive bidding -** In this case, tender notice should be publicized adequately to obtain competitive tenders from competent agencies / contractors for the project; or

NOTE - Electronic tendering could also be considered.

b) **Limited competitive bidding -** In large, specialized and important works, prequalification of contractors shall be done considering their financial capability, bid capacity, experience of similar type of works, past performance, technical staff, and plants and machinery available.

7.1.2.3.3.3 Bid evaluation, negotiation and award of work

After due evaluation and negotiation with the bidders, if required, the work shall be awarded to the construction agency based on competitive technical and financial bids.

7.1.2.4 Construction

This is one of the most important stages of construction management where pre-construction stage outputs are realized into physical tangible form within the constraints of time and cost. The intent or need for functional and physical characteristics, defined in the pre-construction stage outputs through specifications, drawings and consolidated project brief is realized through various construction project management functions described in 7.1.3 and particularly through procurement management, time management, cost management, quality management and health, safety and environment management.

7.1.2.5 Commissioning and Handing Over

After all construction activities of the project are complete as per specifications and designs, project commissioning and handing over stage follows. It shall need the compliance of the following:

a) Clearing of site,
b) Removal of all defects at the time of completion and during defect liability period,
c) Preparation of list of inventories,
d) Certification and settlement of construction agency's final bills for payment,
e) Obtaining completion certificate from local government bodies/departments,
f) Preparation of maintenance manual,
g) Performance compliance verification of built facility,
h) Handing over all other required documents, including guarantees, to the client/owner,
i) Restoration of surroundings, and
j) Preparation and handing over all as-built drawings.

7.1.3 CONSTRUCTION PROJECT MANAGEMENT FUNCTIONS

Construction project management consists of number of processes and these can be grouped under the following management functions:

a) Scope management,
b) Procurement management,
c) Time management,
d) Cost management,
e) Quality management,
f) Risk management,
g) Communication management,

h) Human resources management,
i) Health and safety management,
j) Sustainability management,
k) Integration management, and
l) Other management processes.

The project management functions briefly described below may be employed for effective management of construction project during its different stages as applicable. Some of the processes may, however, overlap more than one function.

7.1.3.1 Scope Management

It should be ensured that project concept, details and functions which are established and recorded during the finalization stage, remain same except minor changes and/or authorized variations. Scope management includes the processes of scope planning, scope definition, scope verification, scope monitoring, and change control.

Scope planning, scope definition and scope verification are associated with the preconstruction phase of the project. Scope monitoring and change control are critical to the construction/installation stage in order to control time and cost over-runs. The work break down structure of the project shall be the basic tool for defining the scope baseline. Scope control should aim to identify factors influencing scope change, determine the impact of scope changes and establish the system for scope change approval and revision of scope baseline. Accordingly, a detailed scope management plan should be drawn to lay down all the necessary practices including technical and organizational interfaces.

For detailed guidelines, reference shall be made to **Suffix [7(3)].**

7.1.3.2 Procurement Management

Procurement management includes processes for purchase of materials, equipment, products, soliciting services of consultants and engaging agencies for execution of works under a contract. Project procurement processes, which depend on type of project delivery model include identification of procurement needs, preparation for procurement, soliciting proposals, selection of suppliers/consultants/ works contractors, administering of contract, contract management and closure of contract. Project manager is charged with the responsibility to help structure and develop contract to suit the specific needs of the project. As contract, which is an output of project procurement management processes, is a legal document, the procurement processes should follow detailed procedures with adequate review and stakeholder appraisal opportunities.

One of the fundamental issues in construction projects, managed through project managers, is to determine what needs may be met by procuring products, services and works from external agencies and what should be accomplished by the project team. This decision is best arrived at the earlier stages of the project (so that the opportunities of procurement initiation at earlier stages is not lost) and reviewed at each of the subsequent life cycle stages of the project. Such decisions should draw inputs from the time, cost, quality and scope management processes. Various procurement routes should be analysed on their suitability to both time and cost criteria of project. As a strategy for procurement, a project procurement management plan should be developed to document: contract types to be used; procurement documents; coordination of procurement with schedules; constraints and assumptions; risk mitigation activities (performance bonds, insurances, etc); and pre-qualification of suppliers. In addition, specifications, quality standards, performance data at work locations, etc., which are part of project scope statement, should be described. Inventory management plays an important role in the procurement management process.

Provision of establishment of suitable dispute redressal system should be inbuilt to take care of any disputes that may arise.

For detailed guidelines, reference shall be made to **Suffix [7(4)].**

7.1.3.3 Time Management

Time management aims to complete the project within the stipulated time period. Time management essentially involves the following processes:

a) Defining project scope in the form of work breakdown structure to generate activity identification and listing,
b) Activity duration estimating,
c) Activity sequencing with interactivity dependencies,
d) Project schedule development, and
e) Project schedule control.

Work breakdown structure should be used as a tool to prepare the project schedule by defining the project scope and identifying and listing of the activities in the work packages. For the quantum of work involved in the activities, the activity durations are estimated based on the standard productivity norms for different trades of work. Past-documented experience and expertise should also be used for determination of the activity durations with the construction technology adopted and manpower and equipment resources used. Based on the construction methodology proposed with the consideration of project specific constraints, the sequencing and interdependencies of the activities are determined and the graphical representation of activities in the form of network should be prepared. The network thus prepared should be analysed to develop the project schedule with information on early and late start and finishing of activities with their available floats and the critical path/critical activities on the network. Incorporating the calendar dates, the baseline schedule may be finalized with the incorporation of milestones for subsequent schedule monitoring and control processes.

During the construction stage, schedule monitoring involves methods of tracking and comparing the actual schedule with the baseline schedule and schedule control activities should ensure to remove deficiencies and slippages corrected to acceptable levels. Project scheduling and monitoring is a dynamic process and periodic schedule updating should be done for effective monitoring and control process. In the process, the status of each activity should be examined. For completed activities, actual durations utilized, are incorporated; and for activities in progress, balance to complete revised durations and estimated finish dates are determined and incorporated. If the actual schedule lags behind the baseline schedule, various options should be considered to control and bring back the schedule to acceptable levels. The possible control actions, which may be considered, are: possible reduction in activity duration of future activities with alternate technology options, increasing the resources, alteration in the construction logic and activity sequencing, etc.

For detailed guidelines, reference shall be made to **Suffix [7(5)].**

7.1.3.4 Cost Management

The objective of the project cost management is to ensure that the project is completed within the authorized budget. The major processes involved in the cost management are: resource planning, cost estimation, cost budgeting/cost planning and cost monitoring and control. The resource planning involves determination of various types of resources, such as appropriate technology, workforce, materials, equipment and infrastructure facilities, their quantum and their requirements during different stages of the project. Preliminary cost estimate with defined scope of work is required for obtaining the project sanction. Detailed item wise cost estimates with bill of quantities and specifications should be made for tendering and subsequent project execution. The type of contract adopted such as item rate, percentage rate, lump sum and cost

plus, influences the cost management strategy. Most of the cost optimization techniques through value engineering studies are achieved during the preconstruction stage of the project. Value engineering is a useful technique for application in cost management. It is a systematic multi-disciplinary effort directed towards analyzing the functions of project or item for the purpose of achieving the best value at the lowest overall life cycle project cost. It is an established technique for determining value based decisions rather than cost reduction based on change in specifications. Suitability of construction techniques, selection of equipment for specific purposes, considering alternative materials and other design changes are some of the areas of application of value engineering. During construction stage, the efforts are more on control mode for adherence to the budgeted cost. For the purpose of cost control during execution, the time based cost baseline of the project which forms the basis for the measurement and monitoring of cost performance, should be generated. The cost baseline is generated by allocating the overall cost estimate to individual project activities based on the project schedule. Using the cost baseline, the cost control, which comprises the following, should be exercised:

a) Periodical cost reporting,
b) Comparison of the actual cost against the planned cost,
c) Obtaining early warning for corrective actions,
d) Control and monitoring cost changes,
e) Forecasting of final cost at completion based on cost trend and cost changes, and
f) Modification of the cost baseline for authorized cost changes and preparation of revised estimates.
g) For detailed guidelines, reference shall be made to Suffix [7(6)].

7.1.3.5 Quality Management

Quality management in construction aims to achieve required functional and physical characteristics of a constructed facility through management actions including planning, direction and control. Quality is the key determinant of requirements which is expressed through drawings and specifications. Main function of quality management is to achieve quality objective of satisfying requirements through performance evaluation of construction processes and ensure that they are directed towards overall quality. Quality management during construction stage assumes that the design and specifications comprehensively incorporate requirements of users and other stakeholders. Prior to setting out for the construction, the client should completely understand the implications of changes to the design and specifications during the construction stage, which may affect quality.

Although quality is an all-encompassing concept which also has bearing on time and cost aspects, the specific scope of quality management may be limited to its key functions of quality planning, quality assurance and quality control. Quality planning refers to the identification of relevant quality standards and determining how to satisfy them. Quality assurance activities include consistent evaluation of project performance to provide confidence that the project satisfies the relevant quality standards. Quality control monitors project results related to the compliance to quality standards and identifying means to eliminate non-conformity.

On-site operations constitute most of the construction processes. Scope of quality management for on-site operations may be categorized broadly in three distinct stages. In the receiving stage, materials and supplies are inspected and tested for conformance to the specified standards. During ‘in-process stage’, materials and supplies are processed to form project product components wherein process control ensures conformance to the specified standards. In the final stage, inspections and tests monitor the functional and physical performance of the product/service to ensure that they satisfy the requirements.

Planning being an integral part of the quality management, may also consider efficient site layout and its management for on-site operations. In addition to time and cost implications of the site management, the quality performance improves by efficient organization of activities

by way of providing adequate and appropriate conditions for the work processes. Site management needs to consider construction technology constraints with reference to aspects related to space availability such as permanent services, access to site, temporary services, location of material stores, stacking and storage areas and plants, fencing and other temporary structures.

The various organizations connected with the project should have their own quality management systems.

All activities shall be planned and controlled: Project Quality Plan (PQP) has been created and inspection party approved by relevant authority has been assigned to control the project, taking into account the project's magnitude and significance. For detailed guidelines, reference shall be made to **Suffix [7(7)].**

Quality of a project should be planned for all activities from inception to completion. It is desirable that the system planned gives adequate assurance and controls that it shall meet project quality objectives. The system shall cover review of existing requirements, subcontracting, materials, processes and controls during process, auditing, training of personnel, final inspection and acceptance. All activities shall be planned and controlled. Quality systems approach may be referred for planning, suitable to a particular project for implementation.

7.1.3.6 Risk Management

Project risks have an impact on the project objectives and need a planned response. Project risk management processes ensure proper planning, identification, analysis, monitoring and control to the best interest of the project.

Risk management planning processes develop an approach to risk management activities which include planning, execution and monitoring. A risk management plan should define lead and support role responsibilities of project team in relation to management, budgeting, risk responsive scheduling, classification of risk activities based on risk break-down structure and explanation of probability and impact for risk context.

Risk response planning determines actions required for reducing impact of risks. Risk responses are established and assigned to appropriate project participants. Suitable risk mitigation measures should be evolved for identified risks.

For detailed guidelines, reference shall be made to **Suffix [7(8)].**

7.1.3.7 Communication Management

For communication management, Management Information System (MIS) is used as an important tool for systemized approach to furnish information. It comprises a system that collects, stores, sorts and analyses data to generate and communicate information. It may be a combination of manual and computerized systems.

At the construction stage of a project, there are many agencies involved like client, architect, engineer, project manager, various consultants, material suppliers, construction agencies and sub-contractors. Each agency is divided into top level management taking policy decisions, middle level management monitoring the project and lower level management involved in day to day operations of the project.

Each level of management requires information of varying details, at different periodicities and in different formats. Project progress information flows from lower level to the top level management and policy decisions flow from top level to the lower level management.

MIS integrates the work and information flow within each agency and flow of information between different agencies.

In construction stage of the projects, the information may be in the form of data reflecting status of project in terms of actual execution time for each activity, cost incurred, resources

used, quality control, material management, bills, organization management and other administrative aspects like disputes that may come up. This data should be analyzed to understand the overall progress achieved and to update schedules of the project.

Basic objectives of MIS of a construction project may be summarized as:

a) Providing benchmark against which to measure or compare progress and costs, like time network schedules, cost estimates, material and labour schedules, specifications, working drawings.
b) Providing an organized and efficient means of measuring, collecting, verifying and reflecting the progress and status of operations on the project with respect to progress, cost, resources and quality.
c) Providing an organized, accurate and efficient means of converting the data from operations into information.
d) Reporting the correct and necessary information in the required format and at the required level of detail to managers at all levels and to the supervisors.
e) Identifying and isolating the most important and critical information at various stages to be communicated to the managers and supervisors for taking decisions.
f) Communicating the information to the managers and supervisors in time so that decisions may be taken at the right time.

Total MIS configuration of the construction project may be divided into the following modules:

1) Planning and scheduling module,
2) Cost control and accounting module,
3) Trend and forecast module,
4) Project administrative and financial module, and
5) Historical and documentation module.

All modules should be interlinked in flow of information and generation of reports. For large public projects, suitable mechanism may be established for communication of relevant information to public at large.

For detailed guidelines, reference shall be made to **Suffix [7(9)].**

7.1.3.8 Human Resource Management

All construction projects involve large number of skilled/unskilled persons. Human resources in a project should be adequately qualified, trained and competent.

Quality of construction work depends on the quality of labour resource. For skilled and un-skilled labour, the requirement for technical knowledge, skill and general awareness are varied for different construction processes. Labourers are required to understand their respective responsibilities especially towards the work. Therefore, construction management practices should emphasize on development of competence of this critical human resource through training programmes.

The critical activities should be identified from the point of view of technological innovations, workmanship and environmental conditions which determine labour behaviour and performance. In each construction project, there are certain work related peculiarities which call for job specific orientation. There should be a clearly defined competence requirement for the workers. Progressively, a formal training or a certified course undertaken should be a preferred selection criterion for the workers. All efforts should also be made to impart on site skilling/training of construction workers for specific tasks. A periodic review of the performance may be made to establish the nature of training required and methods for imparting training. There is a need to address the motivational aspects, for better performance.For detailed guidelines, reference shall be made to **Suffix [7(10)].**

7.1.3.9 Health, Safety and Environmental Management

7.1.3.9.1 Health management issues include looking into the risk factors to health of construction personnel and providing hygienic conditions at construction sites and methods of their management. It includes managing,

a) occupational/physical health hazards.
b) short term as well as long-term ill effects of the activities and the working environment of the construction sites.
c) provision of personal protective equipment required for specific health hazards.
d) laying down of construction hygiene control methods.

7.1.3.9.2 Safety management issues include managing work processes, equipment and material handling at site for striving to achieve zero accident status at site. For prevention and management of accidents, a proper organizational and administrative mechanism is required. Following steps should be taken for achieving the same:

a) Laying down of safety regulations or mandatory prescriptions concerning different work processes.
b) Standardization of work processes and management actions.
c) Regular and stipulated inspection of works and machinery/equipment for enforcement of mandatory regulations.
d) Providing education and training to workers on safety issues.
e) Publicity and appeal to develop safety consciousness.
f) Insurance of built facilities, construction personnel and third party.
g) Regular safety audit of construction sites and post audit actions.
h) Effective post-accident action including accident analysis and reporting.
i) Effective post-accident management including corrective measures to avoid repetition of such accidents.

Safety Officer shall be appointed in accordance with the concerned provisions of the Building and Other Construction Workers. Safety officer who is posted at a medium to major construction site shall:

1) Look after the safety of the personnel, safe handling of materials and machinery, safe work practices and standard operating procedures.
2) Be responsible for compliance of all statutory obligations of the employer in regard to safety of personnel and structures.
3) Guide and assist the site managers/engineers to make their sites safe and accident free.
4) Train personnel in construction safety, conduct safety surveys and design suitable documents for recording and promoting safety on sites and in the construction industry.
5) Arrange for safety briefing for all the persons entering the construction area. For detailed guidelines, reference shall be made to **Suffix [7(11)].**

7.1.3.10 Sustainability Management

7.1.3.10.1 Sustainability management issues include the following:

a) Minimizing adverse environmental impact of activities, products and services.
b) Limiting any adverse impact within the laws/prescribed norms and their monitoring.
c) Safety of environment while working with hazardous materials and maintaining material safety data sheets.
d) Management of disposal of waste from the construction sites.
e) Considering positive environmental contribution particularly after completion of construction.
f) Mechanism to review concerns of interested parties.

For detailed guidelines, reference shall be made to **Suffix [7(12)].**

7.1.3.11 Integration Management

Integration management aims to provide processes necessary for coordination amongst various organizations and their teams involved. It ensures that various organizational teams perform in an integrated manner, with their actions coordinated to the mutual interests towards the project. Integrated management processes provide opportunities for resolving conflicts and competing interests through appropriate tradeoffs. Integration is necessary where processes interact, especially when process responsibilities belong to different organizational groups. Such process interactions need organizational interfaces to be defined and resolved at an overall level.

Integration management may also be required for specific situations when impact of one management function is a cause for concern for other management functions. For example, if there is a time delay in performing a particular construction process, it may often have impact on the cost aspects of not only that process but other processes involving other organizational groups; the rescheduling may affect coordination amongst performing groups in the downstream processes and activities.

For detailed guidelines, reference shall be made to **Suffix [7(13)].**

7.1.4 CONSTRUCTION PLANNING AND SITE MANAGEMENT

7.1.4.1 Planning Aspects

Construction planning aspects aim to identify and develop various stages of project execution on site which should be consistent with the management considerations. Planning aspects evolve out of the objectives of project and requirements of the final completed constructed facility. These objectives could relate to the all foreseeable constraints such as time constraints, budget and cost considerations, quality standards, safety standards, environmental considerations and health considerations. Construction practices would, then have to satisfy these objectives during construction phase of the project.

Having established objectives of the construction phase, planning determines processes, resources (including materials, equipment, human and environmental) and monitoring system to ensure that the practices are appropriately aligned. Adequate knowledge about preconstruction phase evolution of project, especially related to customer’s requirements, is an essential prerequisite for construction planning.

7.1.4.2 Preconstruction Phase

a) Besides the design aspects, preconstruction phase should also address all the issues related to the implementation of the design at the site through suitable construction strategy. During the design stage, the site conditions should be fully understood with anticipated difficulties and avoid the risk of subsequent delays and changes after the construction has started.

b) The selection of construction methods, building systems and materials, components, manpower and equipment and techniques are best done in the preconstruction phase. Such selection is influenced by the local conditions like terrain, climate, vulnerability for disasters, etc.

c) Construction in busy localities of cities needs special considerations and meticulous planning due to restricted space, adjoining structures, underground utilities, traffic restrictions, noise and environmental pollution and other specific site constraints.

d) The constructability aspects of the proposed construction methods needs to be carefully evaluated at the planning stage to ensure ease of construction besides optimizing the construction schedule and achieving quality, reliability and maintainability of the constructed facilities.

e) Construction practices in hilly regions needs to take into considerations the problem of landslides, slope stability, drainage, etc., besides ensuring no adverse impact on the fragile environmental conditions.
f) Durability of constructions in corrosive atmospheric conditions like coastal regions and aggressive ground situations with high chlorides and sulphates should also be taken care of with appropriate construction practices.
g) Construction practices in disaster prone areas need specific planning. The type of construction, use of materials, construction techniques require special considerations in such areas.
h) Adverse weather conditions have strong bearing on construction phase. Situations wherein constructions are to be carried out in adverse weather conditions, such as heavy and continuous rain fall, extreme hot or cold weather, dust storms, etc., the practices have to address the relevant aspects. Accordingly, the design and field operations should be adapted or redefined based on considerations, such as the following:
    1) Site layout which enables accessibility in adverse weather.
    2) Adequate protected storage for weather sensitive materials/equipment.
    3) Protection to personnel from extreme hot/cold conditions.
    4) Scheduling to allow maximization of outdoor activities during fair weather conditions.
    5) Special design and construction provisions for activities in extreme temperature conditions like hot or cold weather concreting, stability of false work in extreme wind conditions (gusts).
    6) Adequate lighting for shorter days in winter/ night work.
    7) Design for early enclosure.

7.1.4.3 Resource Planning

Resource planning aims to identify requirement, availability and regulatory/control processes related to resources. Resource planning is a generic expression but the actual process of planning is specific to the resources considered.

In construction phases, the resources could be categorized as materials, manufactured products, equipment for construction, installation and fabrication, human resources as a part of overall organization, information resources such as reference standards and other practice documents, environmental conditions for work on site, infrastructure facilities and cash flow. Therefore, the resource planning encompasses identification, estimation, scheduling and allocation of resources. Resource planning needs to establish a control system for controlling consumption monitoring, corrective action and resource reappropriation in the event of favorable deviation. Organizational capability, commitment to the project requirements and other constraints such as time and cost, need to be considered as inputs while planning resources. Techniques of management and planning such as Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM) may be used.

Non-availability of basic building materials (brick, stone, aggregate, etc) within reasonable lead would influence the construction practice by alternative materials. The construction practices also get decided by the local skills of the manpower for construction activities. The equipment selection would also be governed by the site constraints. Therefore, as, the resource planning is critical to the project viability itself, the inputs to the resource planning need to be validated appropriately and established for such management. Resource planning should establish a proper system of data collection so as to facilitate effective resources control mechanism. Resource planning responsibility has to be specifically defined in the overall organizational setup.

7.1.4.4 Construction Phase

7.1.4.4.1 Organizational Structure

The site management should be carried out through suitable site organization structure with roles and responsibilities assigned to the construction personnel for various construction related functions. Health, Safety and Enviromental management is one of the important components of site management.

7.1.4.4.2 Site Management

7.1.4.4.2.1 Site layout

The layout of the construction site should be carefully planned keeping in view the various requirements of construction activities and the specific constraints in terms of its size, shape, topography, traffic, and other restrictions, in public interest. A well planned site layout would enable safe smooth and efficient construction operations. The site layout should take into considerations the following factors:

a) Easy access and exit, with proper parking of vehicle and equipment during construction
b) Properly located material stores for easy handling and storage.
c) Adequate stack areas for bulk construction materials.
d) Optimum location of plants and equipment (batching plants, etc).
e) Layout of temporary services (water, power, power suppression unit, hoists, cranes, elevators, etc).
f) Adequate yard lighting and lighting for night shifts.
g) Temporary buildings; site office and shelter for workers with use of noncombustible materials as far as possible including emergency medical aids.
h) Roads for vehicular movement with effective drainage plan.
i) Construction safety with emergency access and evacuations and security measures.
j) Fabrication yards for reinforcement assembly, concrete pre-casting and shuttering materials.
k) Fencing, barricades and signages.

7.1.4.4.2.2 Access for firefighting equipment vehicles

Access for firefighting equipment shall be provided to the construction site at the start of construction and maintained until all construction work is completed. Free access from the street to fire hydrants/static water tanks, where available, shall be provided and maintained at all times. No materials for construction shall be placed within 3 m of hydrants/static water tanks. During building operations, free access to permanent, temporary or portable first-aid firefighting equipment shall be maintained at all times.

7.1.4.4.2.3 Access to the upper floors during construction

In all buildings over two stories high, at least one stairway shall be provided in usable condition at all times. This stairway shall be extended upward as each floor is completed. There shall be a handrail on the staircase.

7.1.4.4.2.4 Electrical installations

Electrical installations, both permanent and temporary, for construction and demolition sites, including electrical installations for transportable construction buildings (site sheds) shall be in accordance with -Building Services, Section 2 Electrical and Allied Installations' of the Code.

7.1.4.4.3 Construction Strategy and Construction Sequence

Construction strategy and construction methods are to be evolved at the planning and design stage specific to the conditions and constraints of the project site and implemented by

the site management personnel to ensure ease of construction and smooth flow of construction activities.

Sites of high water table conditions with aggressive chemical contents of subsoil needs special design considerations. Buildings with basement in sites of high water table should be planned with dewatering scheme with appropriate construction sequence. Duration of dewatering should continue till sufficient dead loads are achieved to stabilize the buoyancy loads with adequate factor of safety. The construction sequence should be planned taking into consideration the following aspects:

Availability of resources (men, material and equipment);

a) Construction methods employed including pre-fabrication;
b) Planned construction time;
c) Design requirements and load transfer mechanism;
d) Stability of ground like in hilly terrain;
e) Ensuring slope stability with retaining structure before the main construction;
f) Installation and movement of heavy equipment like cranes and piling equipment;
g) Effect of weather; and
h) Minimum time to be spent on working below ground level.

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7.2 CONSTRUCTION CONTROL AND PRACTICES

7.2.1 Professional Services and Responsibilities

The responsibility of professionals with regard to planning designing and supervision of building construction work, etc and that of the owner shall be in accordance with 'Planning and Administration'. All applications for permits and issuance of certificates, etc shall be as given in 'Planning and Administration'. Employment of trained workers shall be encouraged for building construction activity.

7.2.2 Site Preparation

7.2.2.1 While preparing the site for construction, bush and other wood, debris, etc, shall be removed and promptly disposed of so as to minimize the attendant hazards.

7.2.2.2 Temporary buildings for construction offices and storage shall be so located as to cause the minimum fire hazards and shall be constructed from noncombustible materials as far as possible.

7.2.3 Construction of All Elements

Construction of all elements of a building shall be in accordance with **Suffix [7(14)].** It shall also be ensured that the elements of structure satisfy the appropriate fire resistance requirements as specified in 'Part 5F, Fire Protection Systems', and quality of building materials/components used shall be in accordance with 'Part 6 Building Materials'.

7.2.3.1 Construction for Foundation

a) Excavations near footings or foundations

Excavations for any purpose shall not remove lateral support from any footing or foundation without first underpinning or protecting the footing or foundation against settlement or lateral translation.

b) Placement of backfill

The excavation outside the foundation shall be backfilled with soil that is free of organic material, construction debris, cobbles and boulders or a controlled low-strength material

(CLSM). The backfill shall be placed in lifts and compacted, in a manner that does not damage the foundation or the waterproofing or damp proofing material.

Exception: Controlled low-strength material need not be compacted.

c) Site grading

The ground immediately adjacent to the foundation shall be sloped away from the building at a slope of not less than one unit vertical in 20 units horizontal (5-percent slope) for a minimum distance of 10 feet (3048 mm) measured perpendicular to the face of the wall. If physical obstructions or plot lines prohibit 10 feet (3048 mm) of horizontal distance, a 5-percent slope shall be provided to an approved alternative method of diverting water away from the foundation. Swales used for this purpose shall be sloped a minimum of 2 percent where located within 10 feet (3048 mm) of the building foundation. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped a minimum of 2 percent away from the building.

Exception: Where climatic or soil conditions warrant, the slope of the ground away from the building foundation is permitted to be reduced to not less than one unit vertical in 48 units horizontal (2-percent slope). The procedure used to establish the final ground level adjacent to the foundation shall account for additional settlement of the backfill.

d) Grading and fill in flood hazard areas

In flood hazard areas, grading or fill shall not be approved:

1) Unless such fill is placed, compacted and sloped to minimize shifting, slumping and erosion during the rise and fall of flood water and, as applicable, wave action.
2) In floodways, unless it has been demonstrated through hydrologic and hydraulic analyses performed by a register -ed design professional in accordance with standard engineering practice that the proposed grading or fill, or both, will not result in any increase in flood levels during the occurrence of the design flood.
3) In flood hazard areas subject to high-velocity wave action, unless such fill is conducted and/or placed to avoid diversion of water and waves toward any building or structure.
4) Where design flood elevations are specified but floodways have not been designated, unless it has been demonstrated that the cumulative effect of the proposed flood hazard area encroachment, when combined with all other existing and anticipated flood hazard area encroachment, will not increase the design flood elevation more than 1 foot (305 mm) at any point.

e) Compacted fill materials

Where footings will bear on compacted fill material, the compacted fill shall comply with the provisions of an approved report, which shall contain the following:

1) Specifications for the preparation of the site prior to placement of compacted fill material.
2) Specifications for material to be used as compacted fill.
3) Test method to be used to determine the maximum dry density and optimum moisture content of the material to be used as compacted fill.
4) Maximum allowable thickness of each lift of compacted fill material.
5) Field test method for determining the in-place dry density of the compacted fill.
6) Minimum acceptable in-place dry density expressed as a percentage of the maximum dry density determined in accordance with Item 3.
7) Number and frequency of field tests required to determine compliance with Item 6.

Exception: Compacted fill material less than 12 inches (305 mm) in depth need not comply with an approved report. The compaction shall be verified by a qualified inspector approved by the building official.

f) Controlled low-strength materials (CLSM)

Where footings will bear on controlled low-strength material (CLSM), the CLSM shall comply with the provisions of an approved report, which shall contain the following:

1) Specifications for the preparation of the site prior to placement of the CLSM.
2) Specifications for the CLSM.
3) Laboratory or field test method(s) to be used to determine the compressive strength or bearing capacity of the CLSM.
4) Test methods for determining the acceptance of the CLSM in the field.
5) Number and frequency of field tests required to determine compliance with item 4.

7.2.3.1.1 Footing and Foundation

Depth of footings

The minimum depth of footings below the undisturbed ground surface shall be 12 inches (305mm).

Frost protection

Except where otherwise protected from frost, foundation walls, piers and other permanent supports of buildings and structures shall be protected by one or more of the following methods:

1) Extending below the frost line of the locality.

2) Erecting on solid rock.

Exception: Free-standing buildings meeting all of the following conditions shall not be required to be protected Footings shall not bear on frozen soil unless such frozen condition is of a permanent character.

Isolated footings

Footings on granular soil shall be so located that the line drawn between the lower edges of adjoining footings shall not have a slope steeper than 30 degrees (0.52 rad) with the horizontal, unless the material supporting the higher footing is braced or retained or otherwise laterally supported in an approved manner or a greater slope has been properly established by engineering analysis.

Shifting or moving soils

Where it is known that the shallow subsoil are of a shifting or moving character, footings shall be carried to a sufficient depth to ensure stability.

7.2.3.1.2 Footings on or adjacent to slopes

The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three unit horizontal (33.3-percent slope).

a) Building clearance from ascending slopes

In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. The following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.

b) Footing setback from descending slope surface

Footings on or adjacent to slope surfaces shall be founded in firm material with an embedment and set back from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. Where the slope is steeper than 1 unit vertical in 1 unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degree (0.79 rad) to the horizontal, projected upward from the toe of the slope.

c) Pools

The setback between pools regulated by this code and slopes shall be equal to one-half the building footing setback distance required by this section. That portion of the pool wall within a horizontal distance of 7 feet (2134 mm) from the top of the slope shall be capable of supporting the water in the pool without soil support.

7.2.3.2 Construction Using Masonry

7.2.3.2.1 Soaking of Brick

Bricks shall be soaked in water before use for a period that is sufficient for the water to just penetrate the whole depth of the bricks. Wetting the bricks assists in removing the dirt, sand and dust from them. Further, it prevents the suction of water from the wet mortar, as otherwise the mortar is likely to dry out soon and crumble before attaining any strength. The bricks shall not be too wet at the time of use, as they are likely to slip on the mortar bed and there will be difficulty in ensuring plumbness of the wall. Moreover, proper adhesion of bricks to mortar will not be possible if the bricks are too wet.

The period of soaking may be easily found at site by a field test in which the brick soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in the construction work. If the bricks are soaked for the required time in water that is frequently changed, the soluble salt in the brick will be leached out, and subsequent efflorescence will be reduced.

When bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place, where they are not again spoiled by dirt, earth, etc.

7.2.3.2.2 Laying of Brick

Brick shall be laid on a full bed of mortar when laying, the bricks shall be slightly pressed so that the mortar gets into all the pores of the brick surface to ensure proper adhesion. Cross joints and wall joints shall be properly flushed and packed with mortar so that no hollow spaces are left. Properly filled joints ensure maximum strength and resistance to penetration of moisture which takes place mainly through joints. In the case of thick walls (two-brick thick and over), the joints shall be grouted at every course in addition to bedding and flushing with mortar. The course at the top of the plinth and sills at the top of the wall just below the roof slab or floor slab and at the top of the parapet, shall be laid with bricks on edge (applicable only in the case of traditional bricks); and at corners and dead ends the bricks shall be properly radiated and keyed into position by using cut-bricks.

Bricks with 20 mm deep frog shall be used frog-down. Bricks with 10 mm deep frog shall be used either frog-up or frog-down.

The courses shall be aligned and care shall be taken to keep the perpends.

The brickwork shall be built in uniform layers; corners and other advanced work shall be racked back. No part of a wall during its construction shall rise more than one meter above the general construction level, to avoid unequal settlement and also improper jointing.

The face joints shall be finished either by jointing by pointing as specified.

Toothing may be done where future extension is contemplated but shall not be used as an alternative to racking back.

a) Walls

All quoins shall be accurately constructed and the height of the courses checked with storey rods as the work proceeds. In general, quoin bricks shall be headers and stretchers in alternate courses, the bond being established by placing a quoin closer next to the queen header.

Acute and obtuse quoins shall be bonded, where practicable, in the same way as square quoins. Obtuse quoins shall be formed with squints showing a three-quarter brick on one face and a quarter brick on the other.

b) Plasters

These shall be set out as to avoid broken bond. The depth of reveals and rebates shall, where practicable, conform to standard brick sizes in order to avoid cutting of bricks and thereby weakening the work. The arrangement of bond at quoins at jambs of openings shall be symmetrical. Partition for half-brick partitions to be keyed into main walls.

c) Arches

Arches shall be turned with ordinary bricks over time. For face work, the bricks shall be either specially manufactured bricks or ordinary bricks cut and rubbed to shape in order to obtain uniform radial joints.

Flat arches may be used for the sake of appearance, but for purpose of carrying loads of the wall above they shall be used in condition with relieving arches, or with lintels placed.

In the construction of a flat arch, though the extrados is perfectly level; the intrados is given a sight camber to allow for any slight settlement or to correct the apparent sagging of a horizontal line, the usual allowance being about 1 mm rise. at the centre for every 100 mm of span.

Large arches in masonary shall be constructed in accordance with IS 2118:1980.

d) Fixing of Frame

Where door or window frames of timber are fixed in the openings, the fixing shall be done, generally with hold-fasts of adequate size and strength securely embedded in the brickwork or in chases later filled up by cement, mortar or concrete. Hold-firsts shall be fixed in the brickwork for a sufficient length and then burned up at end into a cross joint, thus avoiding indiscriminate cutting of bricks. Iron hold-fasts shall be given a protective coat of bitumen to avoid rusting. Woodwork faces in contact with brickwork shall be treated with wood preservative to prevent attack from insects and termites.

The frames shall preferably fixed simultaneously as the masonry work ‘proceed* as, this construction will ensure, proper bond without gaps between the masonry and the frames.

e) Reinforced Brickwork

Reinforcement in half-brick partition walls may be in the form of mild steel flats or hoop iron, expanded mesh, or mild steel bars or fabric. ‘These are generally used in every third or fourth courses of the brickwork. They shall be securely anchored at their ends where the partitions bond.

In this case of round bars used as reinforcement, the diameter shall not exceed 8 mm. Flat bars and similar reinforcement shall not have a thickness exceeding 8 mm. The thickness of reinforced brick wall shall be not less than 100 mm.

The crushing strength of the bricks used in reinforced brick masonry shall be not less than 7.5 N/mm2.

The mortar used for reinforced brickwork shall generally be rich, dense, cement mortar of mix about 1:4. Lime mortars shall not be used.

The inlaid steel reinforcement shall be completely embedded in mortar. Overlaps in the reinforcement, if any, shall not be less than 300 mm.

The mortar covering in the direction of joints shall be not less than 15 mm.

The mortar interposed between the reinforcement bars and the brick shall be not less than 5 mm thick.

In the case where the reinforcements cross inside a joint, the diameter of the reinforcement shall not exceed 5 mm, unless specially shaped bricks are used to permit larger reinforcement.

f) Protection against Damage

Care shall be taken during construction that edges of jambs, sills, heads, etc, are not damaged.

In inclement weather, newly built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away.

Curing in hot and dry weather, the mortar is likely to dry up before it has attained its final set and may crumble. This shall be prevented by keeping the brickwork constantly wet for at least seven days, except in the case of brickwork with mud mortar for which no such curing is required.

g) Provision for Service Instillations

To facilitate taking service lines ‘later without inordinate cutting, of completed work, sleeves and chases shall be provided during the construction itself. Such sleeves shall slope down outwards in external walls so that their surface cannot form channels for the easy passage of water inside.

h) Cavity Walls

As the main object of providing a continuous cavity in an external wall is to prevent rain penetrating to the inner face, care shall be exercised during construction that the cavity is continuous and free from obstruction. As far as possible, mortar droppings shall be prevented from falling down the cavity by the use of laths or by hay bands which shall be drawn up the cavity as the work proceeds. Any mortar which may unavoidably fall on the wall-ties be removed daily and temporary openings shall be provided to permit the daily removal of mortar droppings from the bottom of the cavity.

Special precautions as laid down shall be taken in building flues adjacent to cavities.

Bond in building hollow walls of half-brick thickness, only stretcher bond shall be used, unless purpose made snap header are available. When header bricks are cut and used, they are either likely to protrude into the cavity and form ledges for mortar droppings to collect or they may be so short as to weaken the structure.

The outer and inner leaves shall be tied by means of wall ties. The wall ties shall preferably be bedded with a right fall towards the exterior part of the wall.

At the base of the cavity wall, the foundations and basement shall be solidly constructed up to 300 mm above the ground level. The air cavity shall begin not less than 200 mm below the upper floor surface of the ground floor and the cavity shall be continued without interruption up to the roof.

i) Ventilation

In order to keep the cavity dry, air slot shall be provided above the ground floor level and below the eave level of the roof to extent of 500 mm ‘area of vents to every 20 m area of the wall.

The following precautions shall be observed at the top of the cavity:

Parapets - If the top of a hollow party wall ends with a parapet, the cavity shall be carried up to the full height of the wall or stopped at the roof-fleshing level.
Eaves - If a roof projects over the top of the wall, the cavity shall be closed at the top.
Party Walls - In a hollow party wall, the top of a cavity shall be closed just above the uppermost ceiling level and the courses over shall be continued in solid brickwork.
A sound-insulating material shall be interposed between the hollow wall and the solid brickwork.
At the points where the two leaves of the hollow wall come into contact (for example, at windows and doors), they shall be separated by a water-tight membrane.
Above the lintels of doors and windows, damp-proof membrane shall be inserted slopping downwards and outwards.
At solid jambs a vertical damp-proof course shall be inserted between the outer and inner parts of the wall.

7.2.3.2.3 Concrete-Block Masonry Work in Foundation and Basement

Construction of Masonry

For single storeyed houses, the hollow of blocks in the foundation and basement masonry shall be filled up with sand and only the top foundation course shall be of solid blocks. But for two or more storeyed houses generally solid concrete blocks should preferably be used in foundation courses, plinth, and basement walls. If hollow blocks are used, their hollows must be filled up with concrete comprising one part of cement, three parts of sand and six parts of gravel or crushed stone of 5 to 20 mm size. In special cases, the hollows may be left unfilled if so approved by the appropriate authority.

In damp soils to prevent the rise of moisture from the ground due to capillary action, the foundation and basement masonry shall be laid in richer mortar. In addition, a damp-proof course shall be provided which may consist of a 25mm layer of 1:2 cement mortars, or an approved type of bituminous course.

7.2.3.2.4 Laying Concrete Block Masonry in Superstructure

a) Use of Mortar in Masonry

Hollow concrete block masonry in superstructure shall be laid in composite mortar comprising one part of cement, one part of lime of sand depending upon the grading of sand). Lesser proportion of sand should be adopted if the sand to be used is either not properly graded or is rather fine and nine to ten parts.

b) Horizontal (Bedding) Joints

Mortar shall be spread over then tire top surface of the block including front and rear shells as well as the webs to a uniform layer of one centimeter thickness. Normally full mortar bedding shall be adopted as it enables fuller utilization of the load-carrying capacity of the blocks. But where the walls carry light loads, such as panel walls, in a framed structure ‘ face-shell ’bedding may be used. In this type of bedding the mortar is spread only over the front and rear shells and not on the webs, which helps to arrest the seepage of water through the joints penetrating to the interior surface of the walls. ’

c) Vertical (Cross) Joints

For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or to the next unit to be laid alongside of it. But it will be more convenient to apply mortar on the edges of the succeeding unit when it is standing vertically and then placing it horizontally well-pressed against the previously laid unit. However, whatever the method used for applying mortar, care must be taken to produce well compacted vertical

joints. '_In the case of two cell blocks, there is a slight depression on their vertical sides, which may also be filled up with mortar where it is considered necessary to secure greater lateral rigidity.

Mortar shall not be spread so much ahead of the actual laying of the units that it tends' to stiffen and lose its plasticity, thereby resulting in poor bond. For most of the work, the joints, both horizontal and vertical, shall be one centimeter thick. Except in the case of extruded-joint construction described later in (d), the mortar shall be raked out from the joint with a trowel to a depth of about one centimeter as each course is laid so as to ensure good bond for the plaster.

When the mortar has stiffened somewhat, it shall be firmly compacted with a jointing tool. This compaction is important, since mortar, while hardening has a tendency to shrink slightly and thus pull away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after the mortar has stiffened to effect intimate contact between the mortar and the masonry unit and obtain a weather-tight joint.

It may be necessary to add mortar, particularly to the vertical joints, to ensure that they are well-filled.

d) Operation for Laying Block Masonry

First Course –The first course of concrete masonry shall be laid with great care, making sure that it is properly aligned, leveled and plumbed, as this will assist the mason in laying succeeding courses to obtain a straight and truly vertical wall. Before laying the first course, the alignment of the wall shall be marked on the foundation footings. The blocks for this course shall first be laid dry that is without mortar over the footing, along a string lightly stretched between properly located corners of the wall in order to determine the correct position of the blocks including those of the cross-walls joining it and also adjust their spacing. When the blocks are set in proper position, the two corner blocks shall be removed, a full mortar bed spread on the footing and these blocks laid back in place truly level and plumb. The string shall then be stretched tightly along the faces of the two corner blocks and the faces of the intermediate ones adjusted to coincide with the line. There after each block shall be removed and re-laid over a bed of mortar. After every three or four blocks have been laid, their correct alignment level and verticality shall be carefully checked.

The construction of walls may be started either at the corners first or started from one end proceeding in the other direction. If the corners of the wall are built first, they shall be built four or five courses higher than the centre of the wall. As each course is laid at the corner, it shall be checked for alignment and level and for being plumb. Each block shall be carefully checked with a level or straight-edge to make certain that the faces of the block are all in the same plane. This precaution is necessary to ensure truly straight and vertical walls. The use of a storey-rod or course-pole, which is simply a board with markings 20 cm apart, provides an accurate method of finding the top of the masonry for each course. All mortar joints shall be one centimeter thick. Each course, in building the corners, shall be stepped back by a half-block and the horizontal spacing of the block shall be checked by placing a mason's level diagonally across the corners of the block.

When filling in the wall between the corners, a mason's line shall be stretched from corner to corner for each course and the top outside edge of each block shall be laid to this line. The manner of handling or gripping the block shall be such as to position the block properly with minimum adjustment. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block or it will stiffen and lose its plasticity. As each block is laid, excess mortar extruding from the joints shall be cut off

with the trowel and thrown back on the mortar board to be reworked into the fresh mortar. If the work is progressing rapidly, the extruded mortar cut from the joints may be applied to the vertical face shells of the block just laid. Should there be any delay long enough for the mortar to stiffen on the block, the mortar shall be removed to the mortar board and reworked. Dead mortar that has been picked up from the scaffold or from the floor shall not be used.

Closure Block -When installing the closure block, all edges of the opening and all four vertical edges of the closure block shall be buttered with mortar. The closure block shall be carefully lowered into place. If any of the mortar falls out leaving an open joint, the closure block shall be removed, fresh mortar applied and the operation repeated.

e) Provisions for Door and Window Frames

A course of solid concrete block masonry shall be provided under doors and window openings or a 10 cm thick precast concrete sill-block under windows. The solid course shall extend for at least 20 cm beyond the opening on either side.

For jambs of very large doors and windows either solid concrete blocks shall be provided or, if hollow units are used, the hollows shall be filled in with concrete of mix 1:3:6. Mild steel bar holdfasts should be so fastened to the door or window frames that these occur at block course level and their ends are embedded in a hollow which shall be filled up with 1:3:6 cement concrete.

f) Provisions for Lintels

Lintels may consist of either a single precast unit or a number of units. They shall be appropriately reinforced. In-situ concrete used for forming a composite lintel with the use of a number of units, shall preferably be of the same mix as of the concrete that is used in the precast units and the composite unit shall also be appropriately reinforced.Where openings occur close to one another a continuous lintel shall be provided.

g) Provision for Roof

The course immediately below the roof slab shall be built with solid blocks. Alternatively, U-shaped units may be used and filled in with 1:3:6 concrete later on.

The top of the roof course shall be finished smooth with a thin layer of 1:3 cement mortars and covered with a coat of crude oil, or craft or oil paper to ensure free movement of the roof.

Where the roof slab projects beyond the external wall face, it shall be provided with a drip.

h) Intersecting Walls

All walls wherever they meet or intersect shall be bonded or tied securely.

1) ***Bearing Walls*** -When two bearing walls meet intersect and the courses are to be laid up at the same time, a true masonry bond between at least 50 percent of the units at the intersection is necessary. When such intersecting bearing walls are laid up separately, pockets with 20 cm maximum vertical spacing shall be left in the first wall laid. The corresponding course of the second wall shall be built into these pockets.

2) ***Non-bearing Walls*** - Meeting or intersecting non-bearing walls shall be bonded in a manner approved by a specialist experienced on such construction. Either of the two methods recommended for bearing walls may be used.

i) Pilasters and Piers

The side walls of long buildings shall be stiffened at regular intervals with pilasters which are about twice the thickness of the wall. Piers often support the ends of long roof trusses such as may be used in machine shed and other buildings. The top courses of block in the pier may be filled with concrete. Hollow concrete block shall not be used for isolated piers unless their hollows are filled up with concrete. The unsupported height of piers shall not exceed eighteen times their least horizontal direction.

7.2.3.2.5 Rendering and Other Finishes

a) External Renderings

As hollow concrete blocks are almost invariably made of lean concrete mixes they will not be impervious and will become damp when exposed to rain. The exterior surface of all hollow concrete block walls shall, therefore, be made waterproof by treating the walls with different types of renderings depending upon the intensity of rainfall, nature of exposure or other reasons. Renderings shall not be applied to the walls when these are wet or in monsoon. The walls must be treated only after they are fully dried. Satisfactory efficiency of the performance of any rendering depends entirely on the surface. bond developed between the rendering and the wall Extreme care shall therefore be taken to ensure effective bond with the wall by preparing the surface, roughening it if necessary, raking out the joints ‘to a depth of at least 10 mm, cleaning the surface of all loose particles and dust, and lightly moistening it with water just Prior to applying the rendering to prevent absorption of water from it. The plaster finishes shall be applied in accordance with IS: 2402-1963 Code of Practice for External Rendered Finishes. The sand used for the plaster finish shall be graded from 3 mm downwards. The plaster shall not be finished smooth, but provided with a coarse finish by means of a wooden float.

In localities where rainfall is heavy or the walls are exposed to sea weather, concrete block masonry shall be rendered with two coats each of 6 to 12 mm thickness of cement mortar as specified by the engineer; the base coat being of 1:3 mix and the finishing coat of 1:3 or 1:4 mix depending upon the severity of the exposure.

In moderate rainfall areas, concrete block masonry shall be rendered with at least one coat of 6 to 12 mm thickness of either 1:4 cement mortar or 1:1:6 cement-lime-sand mortar.

In areas of scarce rainfall, the exterior surface of concrete block masonry may only be pointed with 1:3 cement mortar, and white or color washed.

Where for architectural or other reasons it is necessary to have the concrete block surface exposed, the walls shall either be built with block having richer facing mixture or treated with two coats of approved quality of cement-based paint. In either case the walls in heavy or moderate rainfall areas shall be pointed with 1: 2 cement mortars.

b) Internal Renderings

As machine-made concrete blocks are of uniform size, walls built with them provide a very even surface. Where it is desired to have the block surface exposed, the walls may only be flush pointed and painted with any approved quality of paint including cement paint. Otherwise the interior surface on walls shall be plastered with one coat of 6 to 12 mm thickness of either 1:4 cement mortar or 1:1:6 cement-lime-sand mortar. Where a very smooth finish is desired a second coat of 2 to 3 mm thickness of lime near finish may be applied.

c) Waterproofing Basement Walls below Ground Level

The portion of walls below ground level shall be waterproofed by application of 12 mm thick cement plaster 1:3 mix put on in two coats. The plaster shall be started on the outside

of the wall just below the ground line and continued down the wall and across the edge formed by the projection of the footing. In case the subsoil is wet, the plaster shall be coated with asphalt.

7.2.3.2.6 Laying the Blocks

Gypsum blocks shall preferably not be wetted before laying. Where, however, the suction of the block surfaces in contact with the mortar is so great as to make wetting necessary, only these faces may be wetted using a suitable brush and with the minimum quantity of water.

a) Coursing and Bonding

Gypsum block partitions shall be built in half bond in true level and regular courses.

b) Mortar Joints

The joints shall be as thin as possible. Where the partition is to be plastered, the joint shall be left roughly flush or they may be slightly raked out. If the partition is not to be plastered, the joints shall be neatly finished flush with the face as the work proceeds and care shall be taken to keep the faces clean and free from mortar splashing and stains.

c) Frames for Doors and Other Openings

Where possible frames shall have their posts extending from floor to ceiling to secure a positive fixing to the surrounding structure at both ends and shall have a groove of channel at least 15 mm deep to receive the ends of the blocks.

d) Lintels

The lintel over an opening not more than 0.5 m wide may consist of a single gypsum block having 100 mm bearing at each end.

Where no other support is provided, the lintel over an opening not more than 1.2 m wide may consist of three unreinforced gypsum blocks cut to form a jack-arch. The bearing at each end shall be not less than 350 mm and the bottom side of the key block shall be not more than 500 mm.

The lintel over an opening not more than 1.8 m wide shall consist of gypsum blocks having the upper and lower core holes filled with gypsum mortar and reinforced with 10 mm steel bars. The minimum bearing at each end shall be 100 mm.

Lintels over an opening more than 1.8 m wide shall be a separate lintel designed to support the superincumbent load and having a bearing of not less than 100 mm at each end.

e) Treatment at Heads Partitions

At the ceiling the partitions shall be securely wedged and pinned to the structure above unless special methods of edge isolation are adopted. If the cutting of a cored block exposes the core holes or leaves only a thin shell on top, the core shall be filled solid with mortar before the block is laid. It is essential that the joints in the partition are hardened before any wedging or pinning up is down.

f) Dwarf Partitions

At the head of dwarf partitions lateral supports shall always be provided either by using a capping rail of sufficient rigidity or by staying it to the adjacent main structure.

7.2.3.2.7 Finishing

Gypsum block partitions shall normally be finished with a rendering of gypsum plaster not less than 6 mm thick. Where the partition is not to be rendered, it shall be cleaned down and any defects made good with neat gypsum plaster or with mortar.

7.2.3.2.8 Repairing Brickwork

Defects and cracking in brickwork may be due to one or several causes. Where proper materials and workmanship are used, brickwork will need little maintenance. If, however, defects occur, they may be due to the following causes:

a) Sulphate attack on mortars and renderings,
b) Use of unsound materials,
c) Corrosion of embedded iron or steel,
d) Crystallization of salts from the bricks, and
e) Defects due to shrinkage on drying.

And to execute effective repairs, it is necessary to know the cause of damage. The effect of defect in a wall must be judged in relation to the building as a whole and the general soundness of its construction and the particular function of the wall is called upon to serve. The nature of repairs mainly depends on whether it is structural damage or surface cracking only. At times even wide cracks may not seriously affect the stability of the structure provided the brickwork is not distorted or is not much out of plumb.

Before deciding the course of treatment be adopted to following factors shall be considered:

1) The type of foundation on which the wall is constructed;
2) The position and bonding of cross walls and other connecting structural members;
3) Whether the wall is true to plumb;
4) Whether floors, roofs, upper walls, etc, are liable to exert thrust or restraint to further movement; and
5) The aesthetic effect of the crack over the building as a whole.

a) Treatment of Structural Damage

Where walls become unsafe due to differential movements resulting from seasonal fluctuations in the moisture content of subsoil or due to the presence of filled materials below the foundations, the work may require special measure such as providing reinforced concrete band at plinth level, lintel level, top level, etc, and lowering ground-water table.

For damages other than mentioned in above one of the following treatments may be adopted:

1) To provide tie rods passing through the floor or at roof level anchoring the damaged wall to another wall or structural member that is sound or has tendency to move in the opposite direction.
2) To build buttresses, keyed into the damaged wall so as to give thrust against the wall in the required direction. It shall be ensured that the buttresses rest on firm soil without giving way to settlements or movements.
3) In case the wall is noticed to be out of plumb, the damaged or bulged portion of the wall shall be dismantled and rebuilt with mortar of the same proportion of the adjoining portion.

b) Treatment of Cracks across Wall

These cracks are more or less diagonal cracks and either follow the vertical and horizontal joints alternately or pass straight down through alternate vertical joints and this intervening bricks and mortar beds. In these cases one of the following methods may be adopted:

1) If the cracks are of such nature that they are likely to encourage the penetration of rain if they are not repaired, it is necessary to cut out and replace the cracked bricks.

2) If the cracks are wide, the two portions can be stitched by inserting bond stone or precast reinforced concrete blocks at suitable intervals. The cracks shall then be

grouted. Sufficient care has to be taken in preparing the precast concrete blocks so that the patched surface will match with the surrounding surface. In repairing cracks with mortar it is important to secure satisfactory adhesion between the masonry of the existing work and the new bricks and also not to use too strong a mortar mix Otherwise shrinkage of the new rich mortar may cause a fresh crack to develop. To promote adhesion, the brickwork shall be wetted before the mortar is filled in.

If a number of cracks have appeared in a single wall and the cracks cross each other these cracks cannot be effectively repaired. The walls in such cases have no strength and it is advisable to dismantle the entire wall and reconstruct the same, supporting the structure above in a suitable manner. In case the diagonal cracks have occurred in a localized place of the wall, the brickwork at the damaged place and around shall be dismantled and rebuilt. While dismantling such portions, care shall be taken to relieve the load on the wall by providing props at suitable places. The props or supports for the structure above the work under repair shall not be removed till the rebuilt masonry has attained enough strength.

Where the cracks are likely to continue to widen for sometime after initial development (such as in the case of cracks due to ground movement in shrinkable clay sub-soil) it would be advisable not to repair the cracks with mortar. If filling is found necessary to prevent the penetration of moisture or rain, oil based mastic shall be applied by caulking or by a gun.

c) Surface cracks

Where the mortar in the joints has become damaged without dislocating the brickwork, which may be due to initial usage of poor mortar, improper filling or action of frost or fire or unknown elements of nature, the joints shall be raked thoroughly to a depth of at least 20 mm and the raked joints caulked with mortar and the brickwork pointed. Care shall be taken to avoid the usage of a strong mortar for caulking purposes. The patch work shall be properly cured.

7.2.3.3 Construction Using Bamboo

a) Bamboo being a versatile resource characterized by high strength, low mass and ease of working with simple tools, it is desirable to increasingly make appropriate use of this material.

b) Bamboo can be cut and split easily with very simple hand tools. Inmature bamboos are soft, pliable and can be molded to desired shape. It takes polish and paint well.

c) While it is possible to work with bamboo simply using, a few basic tools, such as, a machete, hack saw, axe, hatchet, sharpening tools, adze, chisel (20 mm), chill, wood rasps, steel rod, and pliers, will greatly increase the effectiveness of the construction process.

d) For providing safety to the structure against fire, bamboo may be given fire retardant treatment using following chemicals: a few drops of concentrated HCL shall be added to the solution to dissolve the precipitated salts:

Ammonium phosphate	3	parts
Boric acid	3	parts
Copper sulphate	1	part
Zinc chloride	5	parts
Sodium dichromate	3	parts
Water	100	parts

e) Bamboo indirect contact with ground, bamboo on rock or preformed concrete footing, bamboo incorporated into concrete or bamboo piles may form the foundation structure.

f) The floor of bamboo may be at ground level with covering of bamboo matting, etc. In elevated floors, bamboo members become an integral part of structural framework of building. The floor will comprise structural bamboo elements and bamboo decking.

7.2.3.4 Construction Using Concrete

7.2.3.4.1 Mixing and Placing of Pneumatic Mortar

a) Mixing-The aggregate and cement should be mixed in an approved mechanical mixer and delivered from an approved mechanical digester. The minimum amount of water should be injected into the mixture as this will ensure maximum density of the mortar.

b) Placing-The pneumatic mortar should be applied with an approved nozzle by a skilled operator. The velocity of the material leaving the nozzle should be maintained uniform and should be such as to produce minimum rebound of sand.

c) Curing - Immediately after pneumatic mortar has been placed it should be protected against premature drying by shading from strong sunshine and shielding from the wind. As soon as it has hardened just sufficiently to avoid damage it should be thoroughly wetted and there after kept wet continuously for at Least seven days. Adequate protection against fluctuations in temperature by shading and shielding shall also be given.

7.2.3.4.2 Construction of Floors

a) Floors Founded on the Ground

The ground should be covered with an at least 75 mm thick plain concrete. Floors cast on the ground should be in not less than two layers, the bottom layer of which may comprise or replace the plain concrete screed. The screed forms an integral part of the floor slab forming one of the two layers then the mix for screed.

A layer of building paper or other suitable material should be laid between successive layers.

The layers, other than the plain concrete screed, if used; should be placed in panels, the sides of which should not exceed 7.5 m in the case of reinforced slabs and 4.5 m in the case of plain slabs. The tendency for the development of cracks in the upper layer of paving slab or a reservoir floor is greatly diminished if the reinforcement is discontinuous through the joints and it is recommended that the floor panels be laid in chessboard fashion (all the ‘ black ’ or all the ‘ white ’squares first). The edges of the panels in the bottom layer may be butt jointed and the panels in the various layers should be arranged to break joint.

b) Suspended Floors

Floors which are not directly supported on the ground should be cast in panels, the sides of which should not exceed7.5 m. At joints in suspended floors, the surface of the panels for a width not less than the thickness of the panel on each side of the joint should be primed and painted with at least two coats of bituminous or other approved paint.

c) Junction of Floor and Walls

Where the wall is designed to be monolithic with the bottom slab, a suitable arrangement of reinforcement and form-work shall be made to facilitate the form-work to fit tightly and avoid leakage of cement paste from newly deposited concrete as such leakage if allowed to take place is very liable to cause porosity in the finished concrete. One such arrangement is by providing a continuous up stand section of the wall cast at the same time, as, and integrally with, the slab; the height of this up stand must be sufficient to enable the next lift off form-work fit tightly and avoid leakage of the cement paste from the newly deposited concrete construction.

7.2.3.4.3 Construction of Walls

In all cases where the reinforcing steel is discontinuous at vertical contraction joints, the walls should be constructed in alternate panels with as long a pause as practicable before the concrete is placed in the intervening panels.

Where the reinforcement is continuous through vertical joints in walls, construction in alternate panels may result in a greater tendency to the' development of cracks in those panels which are cast between two earlier placed panels, the existence of which increases restraint of the natural shrinkage of the intermediate panel.

The height of any lift should not exceed 2 m unless special precautions are taken to ensure through compaction throughout by mechanical vibration or by other suitable means.

All vertical joints should extend the full height of the wall in unbroken alignment.

7.2.3.4.4 Surface Finish to Prestressed Concrete Cylindrical Tanks

The circumferential prestressing wires of a cylindrical tank should be covered with a protective coat, which may be pneumatic mortar, having a thickness that will provide a minimum cover of 40 mm over the wires.

7.2.3.4.5 Formwork

Bolts passing completely through liquid-retaining slabs for the purpose of securing and aligning the form-work should not be used unless effective precautions are taken to ensure water-tightness after removal.

Lining of Tanks. - The type of liquid to be stored should be considered in relation to the possibility, of corrosion of the steel. Provision of an impermeable protective lining should be considered for resistance to the effects of corrosive liquids. Certain natural waters exhibit corrosive characteristics and in such cases it is important to obtain a dense impermeable concrete and with a higher cement content. An increased cover to the steel is also desirable. Use of sulphate resisting Portland cement, pozzolana cement, of blast-furnace slag cement may in certain cases be advantageous.

7.2.3.4.6 Placement, Protection and Curing

Placement and Finishing

Forms, reinforcement, and sub grade shall be sprinkled with cool water just prior to placement of concrete. The area around the work shall be kept wet to the extent possible to cool the surrounding air and increase its humidity, thereby reducing temperature rise and evaporation from the concrete. When temperature conditions are critical, concrete placement may be restricted to the evenings or night when temperatures are lower and evaporation is less.

Speed of placement and finishing helps to minimize problems in hot weather concreting. Delays contribute to loss of workability and lead to use of additional mixing water to offset such loss. Ample personnel shall be employed to handle and place concrete immediately on delivery. On flat, work; all steps in finishing shall be carried out promptly. Delays in finishing air-entrained concrete pavement in hot weather may lead to formation of a rubbery surface which is impossible to finish without leaving ridges that impair the riding qualities of pavement.

Concrete shall be placed in layers thin enough and in areas small enough so that the time interval between consecutive placements is reduced and vibration or other working of the concrete will ensure complete union of adjacent portions. If cold joints tend to form or if surfaces set and dry too rapidly, or if plastic shrinkage cracks tend to appear, the concrete shall be kept moist by means of fog sprays, wet burlap, cotton mats, or other means. Fog. Sprays applied shortly after placement and before finishing, have been found to be particularly effective in preventing plastic shrinkage cracks when other means have failed.

All placement procedures shall be directed to keep the concrete as cool as practicable and to ensure its setting and hardening under temperature conditions which are reasonably uniform and, under moisture conditions, which will minimize drying. Concrete, whether delivered by a truck or otherwise, shall reach the forms at a temperature not higher than 40°C, and whatever is practicable shall be done to minimize temperature increased using placing, consolidation, finishing, and curing operations. At Protection and Caring-Since, hot weather leads to rapid drying of concrete, protection and curing are far more critical than during cold weather. Particular attention shall be paid to having all surfaces protected from drying. Immediately after consolidation and surface finish, concrete shall be protected from evaporation of moisture, without letting ingress of external water, by means of wet (not dripping) gunny bags, hessian ‘cloth, etc. Once the concrete has attained some degree of hardening sufficient to withstand surface damage (approximately 12 hour after mixing), moist curing shall commence. The actual duration of curing shall depend upon the mix proportions, size of the member as well as the environmental conditions; however in any case it shall not be less than 10 days. Continuous curing is important, because volume change due to alternate wetting and drying promote the development of surface cracking.

Reliance shall not be placed on the protection afforded by Forms for curing in hot weather. If possible, water shall be applied to formed surfaces while forms are still in place and unformed surfaces shall be kept moist by wet curing. The covering material shall be kept soaked by spraying. Steeply sloping and vertical formed surfaces shall be kept completely and continuously moist prior to and during form removal by applying water to top surfaces so that it will pass down between the form and the concrete.

On exposed unformed concrete surfaces, such as pavement slabs, wind is an important factor in the drying rate of concrete. For example, other conditions being equal, a gentle wind of 15 km/h will cause four or more times as much evaporation from a flat surface as still air. Hence windbreakers shall be provided as far as possible.

On hardened concrete and on flat surfaces in particular, curing water shall not be much cooler than the concrete because of the possibilities of thermal stresses and resultant cracking. At the termination of curing with water, an effort shall be made to reduce the rate of drying by avoiding air circulation. This can be accomplished by delay in removal of wet covers until they are dry.

7.2.3.5 Construction Using Steel

7.2.3.5.1 Connections

a) Genera1 - As much of the work of fabrication as is reasonably practicable shall be completed in the shops where the steel work is fabricate.

b) Rivet & Close Tolerance Bolts, High Strength Friction Grip Fasteners, Black Bolts and Welding

Where a connection is subject to impact or’ vibration or to reversal of stress (unless such reversal is due solely to wind) or where for some special reason, such as continuity in rigid framing or precision in alignment of machinery-slipping of bolts is not permissible! Then rivets, close tolerance bolts; high strength friction grip fasteners or welding shall be used. In all other cases bolts in clearance holes may be used provided that due allowance is made for any slippage.

c) Composite Connections

In any connection which takes a force directly communicated to it and which is made with more than one type of fastening, only rivets and turned and fitted bolts may be considered as acting together to share the load. In all other connections sufficient number

of one type of fastening shall be provided to communicate the entire load for which the connection is designed.

d) Members Meeting at a Joint

For triangulated frames designed on the assumption of pin jointed connections, members meeting at a joint shall, where practicable, have their centroidal axes meeting at a point; and wherever practicable the centre of resistance of a. connection shall be on the line of action of the load so as to avoid an eccentricity moment on the connections.

However, where eccentricity of members or of connections is present, the members or the connections shall provide adequate resistance to the induced bending moments.

Where the design is based on non-intersecting members at a joint all stresses arising from the eccentricity of the members shall be calculated and the stresses kept within the limits specified in the appropriate clause of this code.

e) Bearing Brackets

Wherever practicable, connections of beams to columns shall include a bottom bracket and top cleat. Where web cleats are not provided, the bottom bracket shall be capable of carrying the whole of the load.

f) Gussets

Gusset plates shall be designed to resist the shear, direct and flexural stresses acting on the weakest or critical section. Re-entrant cuts shall be avoided as far as practicable.

g) Packing

1) Rivets or Bolts through Packing

Number of rivets or bolts carrying calculated shear through a packing shall be increased above the number required by normal calculations by 2.5 percent for each 2.0 mm thickness of packing except that, for packing having a thickness of 6 mm or less, no increase need be made. For double shear connections packed on both sides, the number of additional rivets or bolts required shall be determined from the thickness of the thicker packing. The additional rivets or bolts should preferably be placed in an extension of the packing.

2) Packing in Welded Construction

Where a packing is used between two parts, the packing and the welds connecting it to each part shall be capable of transmitting the load between the parts. Where the packing is too thin to carry the load or permit the provision of adequate welds, the load shall be transmitted through the welds alone, the welds being increased in size by an amount equal to the thickness of the packing.

3) Packing Subjected to Direct Compression only

Where properly fitted packing are subjected to direct compression only.

h) Separators and Diaphragms

Where two or more rolled steel joists or channels are used side by side to form a girder, they shall be connected together at intervals of not more than 1500 mm except in the case of grillage beams encased in concrete, where suitable provision shall be made to maintain correct spacing. Bolts and separators may be used provided that in beams having a depth of 300 mm or more, not fewer than 2 bolts are used with each separator. When loads are required to be carried from one beam to the other or are required to be distributed between the beams, diaphragms shall be used, designed with sufficient stiffness to distribute the load.

i) Lug Angles

Lug angles connecting a channel-shaped member shall, as far as possible, be disposed symmetrically with respect to the section of the member.

In the case of angle members, the lug: angles and their connections to the gusset or other supporting member shall be capable of developing a strength not less than 20 percent in excess of the force in the outstanding leg of the angle, and the attachment of the lug angle to the angle member shall be capable of developing 40 percent in excess of that force.

In the case of channel members and the like, the lug angles and their connection to the gusset or other supporting member shall be capable of developing strength of not less than 10 percent in excess of the force not accounted for by the direct connection of the member, and the attachment of the lug angles to the member shall be capable of developing20 percent in excess of that force.

In no case shall fewer than two bolts or rivets be used for attaching the lug angle to the gusset or other supporting member.

The effective connection of the lug angle shall, as far as possible terminate at the end of the member connected, and the fastening of the lug angle to the timber shall preferably start in advance of the direct connection of the member to the gusset or other supporting member.

7.2.3.5.2 Shop Erection

The steel work shall be temporarily shop erected complete or as arranged with the inspector so that accuracy of fit may be checked before dispatch. The parts shall be shop assembled with sufficient numbers of parallel drifts to bring and keep the parts in place.

In the case of [arts drilled or punched, through steel jigs with bushes resulting in all similar parts being interchangeable , the steel work may be shop erected in such position as arranged with the inspector.

Packing – All projecting plates or bars and all ends of members at joints shall be stiffened, all straight bars and plates shall be bundled, all screwed ends and machined surfaces shall ne suitably packed and all rivets, bolts, nuts, washers and small loose parts shall be packed separately in cases so as to prevent damage or distortion during transit.

7.2.3.5.3 Inspection and Testing

The inspector shall have free access at all reasonable times to those parts of the manufacturer’s works which are concerned with the fabrication of the steelwork and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with the provisions of this standard.

Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessary with the operation of the work.

The manufacturer shall guarantee compliance with the provisions of this standard, if required to do so by the purchaser.

Should any structure or part of a structure be found not to comply with any of the provisions of this standard, it shall be liable to rejection. No structure or part of the structure, once rejected shall be resubmitted for test, except in cases where the purchaser or his authorized representative considers the defect as rectifiable.

Defects which may appear during fabrication shall be made good with the consent of and according to the procedure laid down by the inspector.

All gauges and templates necessary to satisfy the inspector shall be supplied by the manufacturer. The inspector may, at his discretion, check the test results obtained at the manufacturer’s works by independent tests at the Government Test House or elsewhere, and should the material so tested be found to be unsatisfactory, the costs of such tests shall be borne by the manufacturer, and if satisfactory, the costs shall be borne by the purchaser.

7.2.3.5.4 Site Erection

Plant and Equipment - The suitability and capacity of all plant and equipment used for erection shall be to the satisfaction of the engineer.

Storing and Handling - All structural steel should be so stored and handled at the site that the members are not subjected to excessive stresses and damage.

Setting Out - The positioning and leveling of all steelwork, the plumbing of stanchions and the placing of every part of the structure with accuracy shall be in accordance with the approved drawings and to the satisfaction of the engineer.

7.2.3.5.5 Security During Erection

During erection, the steelwork shall be securely bolted or otherwise fastened and, when necessary,
temporarily braced to provide for all load to be carried by the structure during erection including those due to erection equipment and its operation.

No riveting, permanent bolting or welding should be done until proper alignment has been obtained.

7.2.3.5.6 Field Connections

a) Field riveting - Rivets driven at the site shall be heated and driven with the same care as those driven in the shop.

b) Field bolting - Field bolting shall be carried out with the same care as required for shop bolting.

c) Field welding - All field assembly and welding shall be executed in accordance with the requirements for shop fabrication excepting such as manifestly apply to shop conditions only. Where the steel has been delivered painted, the paint shall be removed before field welding, for a distance of at least 50 mm on either side of the joint.

7.2.3.5.7 Painting after Erection

Before painting of such steel which is delivered unpainted, is commenced, all surfaces to be painted shall be dry and thoroughly cleaned from all loose scale and rust.

The specified protective treatment shall be completed after erection. All rivet and bolt heads and the site welds shall be cleaned. Damaged or deteriorated paint surfaces shall first be made good with the same type of paint as the shop coat. Where specified, surfaces which will be in contact after site assembly shall receive a coat of paint (in addition to any shop priming) and shall be brought together while the paint is still wet.

Where the steel has received a metal coating in the shop, this coating shall be completed on site so as to be continuous over any welds and site rivets or bolts, but subject to the approval of the engineer protection may be completed by panting on site. Bolts which have been galvanized or similarly treated are exempted from this requirement.

7.2.3.5.8 Bedding of Stanchion Bases and Bearings of Beams and Girders on Stone, Brick or Concrete (Plain or Reinforced)

Bedding shall be carried out with portland cement, grout or mortar or fine cement concrete.

For multi storeyed buildings, this operation shall not be carried out until a sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and sufficient floor beams are in position.

Whatever method is employed the operation shall not be carried out until the steelwork has been finally leveled and plumbed the stanchion bases being supported meanwhile by steel wedges; and immediately before grouting, the space under the steel shall be thoroughly cleaned

Bedding of structure shall be carried out with grout or mortar which shall be of adequate strength and shall completely fill the space to be grouted and shall either be placed under pressure or by ramming against fixed supports.

7.2.3.5.9 Construction of Steel Chimney

a) Erection Tolerance

The variation in the eccentricity of the axis of chimney from the vertical at any level shall not exceed 1/1000 of the height, at that particular section.

b) Clearance

Where a chimney passes through a roof or other part of a building, provision shall be made to accommodate the movement of the chimney and to limit the transfer of heat. Normally, an air gap of 50 mm is desirable. Flexible heat resistant packing may be used to fill the gap, if necessary.

c) Sealing

Riveted chimneys shall be caulked, specially if condensation is likely to occur.

d) Gas Tightness

No gaskets shall be used in jointing flanges on structural steels.

NOTE — Liquid sealants are recommended to ensure gas tightness and prevent corrosion in the meeting faces.

e) Erection Tension

The amount of pre-tensioning applied to the guy ropes on site shall be in accordance with the appropriate design considerations and may be measured with a suitable instrument. The tension in the guys after erection shall be not less than 15 percent nor more than 30 percent of the calculated maximum tension due to wind.

7.2.4 Low Income Housing

For low-income housing, appropriate planning and selection of building materials and techniques of construction have to be judiciously done and applied in practice. Requirements of low income housing specified in **- Development Control Rules and General Building Requirements of the Code** shall be followed. However, all requirements regarding structural safety, health safety and fire safety shall be in accordance with this Part.

7.2.5 Use of New/Alternative Construction Techniques

The provisions of this Part are not intended to prevent use of any construction techniques including any alternative materials, not specifically prescribed by the Code, provided any such alternative has been approved. The Authority may approve any such alternative, such as, ferrocement construction; stretcher bond in filler slab; glass fibre reinforced gypsum (GFRG) panel system using composite of GFRG panel and reinforced concrete; pre-engineered steel structures with reinforced concrete expanded polystyrene core based panel/other in-fill walls; light gauge steel framed structures with suitable water resistant wall panels like cement bonded particle board, provided it is found that the proposed alternative is satisfactory and conforms to the provisions of relevant parts regarding material, design and construction and that material, method, or work offered is, for the purpose intended, at least equivalent to that prescribed in the Code in quality, strength, compatibility, effectiveness, fire and water resistance, durability and safety.

7.2.6 Urban Roads/City Roads Planning and Construction

7.2.6.1 The urban roads, which are commonly known as city roads/streets have been under constant development. The emphasis has been primarily on providing essentially required width of metalled surface for the movement of vehicles (both motorized and nonmotorized). Footpaths of various widths and heights are required to be provided.

The space between the buildings and the city roads should be treated as valuable and important space allowing for a comfortable and safe use by the pedestrians, hawkers, cyclists

including non-motorized vehicle (NMV) drivers, and adequate space for drainage, utilities, street lighting poles, transformers and trees. Thus, the objective should be to create urban streets/roads that are efficiently planned, safe for vehicles as well as pedestrians, universally user friendly, and sustainable.

The elements required in an efficiently planned street, such as, kerb stones; kerb channels; kerb ramps; tactile ground surface indicators; silt chambers with manhole cover; drain cover slabs; drain manhole covers; service pipes; manhole covers for electrical services; manhole covers for telecom services; cycle tracks (NMV); bollards across pedestrian paths; tree gratings; lighting poles on main roads and service roads; table tops on free left turns; pedestrian paths at intersections/T-junctions; pedestrian paths on traffic islands; pedestrian paths across central verge; pedestrian paths near rotaries (un-signaled); pedestrian paths below flyovers; signages; traffic signals; cable ducting by discoms; central verge irrigation system; central verge, footpath and traffic islands plantation; street furniture; bus queue shelters; public art, public toilets, etc. should be identified. These elements should be integrated at the planning stage, indicating the methodology of execution, taking care of the following while complying with the relevant rules/regulations:

a) Road cross-section planning based on landuse with emphasis on smooth vehicular movements.

NOTE -This may be achieved by rationalizing lane widths based on norms laid down by Indian Roads Congress.

b) Design of road intersections, fixing of geometrics of roads, providing provision of entry and exits from the service roads.
c) Coordination between the traffic police, transport authorities and the executing agencies to be ensured for efficient location of traffic signals, zebra crossings and the bus queue shelters and the pickup stands for the para-transport.
d) Standardization of kerb stones, kerb ramps and kerb channels.
e) Appropriate selection of materials, like, paver blocks, tiles, stone slabs or plain cement concrete for footpaths, plazas, etc, so that they add to aesthetics of buildings and roads.
f) Standardization of access manhole covers for various utilities.
g) Providing footpath at one level by adjusting the drain cover slab levels.
h) Integration of bus queue shelters with the footpath.
i) Pedestrian friendly access across the roads to the foot-over bridges, subways and public toilets.
j) Access to gates of residential/commercial properties integrated with the road through the footpath in front.
k) Sharing of NMV with footpath necessary at many locations.
l) Adequate provision of public conveniences and dust bins.
m) Street lighting for proper illumination of roads and service roads including modifications of street lighting along with central verge and the service roads blocked by existing trees.
n) Low height plantation on central verges, avoiding plantation of trees.
o) Removal of crooked trees on footpaths for proper and safe utilization of footpath.
p) Removal of trees obstructing the carriage ways and their replantation, wherever feasible.
q) Freeing of trees embedded in the compound wall/dwarf walls on footpaths to save both the trees and the walls.
r) Providing planters in the central verge in the deck portion of flyover to ensure proper glare cutting during night hours and improving aesthetics during the day.
s) Proper location of signage boards so as to be safe from moving traffic near the footpath edges and give clear visibility.
t) Selection, procurement and installation of street furniture.

u) Selection, procurement and installation in respect of accessibility features as per the requirements given in Development Control Rules and General Building Requirements of the Code.

NOTE - The relevant standards/publications of Indian Roads Congress may be referred to.

7.2.6.2 The road work zones are areas of conflict between normal operating traffic, construction workers, road building machineries and construction traffic. If it is a construction of new road, normal operating traffic will not be there but the care has to be taken to avoid and or remove conflicts between workers and construction machineries and construction traffic. Problem becomes more serious if it is an urban road with significant proportion of vulnerable road users. The road work zones and the traffic around them should be so planned and managed so as to ensure traffic safety, facilitate smooth and efficient flow of traffic and also provide safe working environment for the workers.

NOTE- For guidance on management of pedestrians/ cyclists/ vehicles near road construction sites, reference may be made to IRC SP 55: 2014 -Guidelines on traffic management in work zones.

7.2.7 Measures against pollution and hazard due to dust, smoke and debris, such as screens and barricading shall be installed at the site during construction. Plastic/ tarpaulin sheet covers shall be used for trucks transporting fine materials liable to cause environmental pollution.

7.2.8 Temporary Works

7.2.8.1 The construction of most types of permanent works requires the use of some form of temporary works. Temporary works are the parts of a construction project that are needed to enable the permanent works to be built.Usually the temporary works are removed after use, for example, access, scaffolds, props, shoring, excavation support, false work and formwork, etc. Sometimes the temporary works are incorporated into the permanent works, for example, haul road foundations and crane or piling platforms which may be used for hard standing or road foundations. The same degree of care and attention should be given to the design and construction of temporary works as to the design and construction of the permanent works. Considering that as temporary works may be in place for only a short while, there is a tendency to assume they are less important, which is incorrect. Lack of care in design, selection, assembly, etc, leaves temporary works liable to fail or collapse. While organizing the temporary works, aspects as given below should be followed:

a) The person organizing the temporary works should be aware of the problems that can occur at each stage of the process and how to prevent these. They need to coordinate design, selection of equipment, appointment of contractors, supervision of work, checking completion, authorization to load and removal.
b) If so required, a temporary works coordinator (TWC) may be employed in case of medium and large projects, whose requisite qualification and experience should be specified. The role of TWC and supervisor should be decided. The coordinator shall have adequate field training for temporary works. The contractor shall ensure that work is allocated and carried out in a manner that does not create unacceptable risk of harm to workers or members of the public. On projects with relatively simple temporary works needs, a TWC may be avoided, however, it shall be ensured that temporary works are properly managed.
c) The cost of any temporary works is generally included in the build-up of the tender.
d) Temporary works are often taken from site to site and re-used and it is important to consider the robustness of components in their design. However, temporary works that are designed only to be used during construction shall not be removed until the satisfactory safety criteria for their use has been met.

e) Proper planning and co-ordination should be done in respect of sequence and timely execution of temporary works, as also for ensuring that they are correctly installed, used, checked and maintained.

f) In each of the cases of temporary works, the person organizing the temporary works should assess the soil conditions to be sure that it is suitable for the equipment involved, and check that any assumptions made in the calculations for the standard solution are valid for this particular situation and the conditions on site. On a simple job, the supplier's data will allow an experienced person to consider the necessary issues without further calculation.

g) Propping using standard equipment such asscrew props (acrows) needs careful consideration. To select the type, size, number and decide spacing, information is needed about the loads that will act on the props. This will include the wall above and the additional load from any other floor or roof beams, etc, that enter the wall above or close to the opening. Even with proprietary equipment ,the support system shall be worked out.

h) A local failure within the temporary works should not initiate a global collapse of the structure. Therefore, additional care should be taken while removing temporary works. The different types of temporary works can be scaffolding, crane supports, falsework, formwork, and trench support. Detailed knowledge about each type of temporary work is necessary for safe construction. The requirements as given in 7.2 to 7.6 shall be satisfied in case of temporary works.

Proprietary equipment supplier should be identified and approved. It should be ascertained, whether following has been performed:

1) They have designed the foundations,
2) Any assumption made that have to be confirmed/investigated,
3) Independent checking done and by whom,
4) Status of drawings, and
5) Procedures checked at site.

In management of temporary works, the owner/client has to ensure,

1) checks on competence on designers;
2) steps taken to ensure co-operation between the permanent and temporary works designers;
3) coordination at site meetings; and
4) advise clients on the suitability of the initial construction phase plan, that is, the arrangements for controlling significant site risks.

7.2.8.2 Scaffolding

Scaffolding includes providing a temporary safe working platform for erection, maintenance, construction, repair, access, and inspection. Scaffolding and their erection shall be in accordance with the **Suffix [7(15)].**

7.2.8.3 Tower Cranes

Tower cranes are usually supplied on a hire basis, with the client being responsible for the design and construction of the base upon which the crane is erected. Details of loading are provided by the crane supplier and the base is most commonly designed as a temporary structure, though sometimes a crane base is incorporated into the permanent structure to save on cost and time.

Loads are given in two forms, 'in service' loads, where the crane is functioning and wind speeds are restricted (that is, cranes will not operate at high wind speeds), and 'out of service' loads, where the crane is not being used but maximum wind speeds may occur. The location for a crane should be carefully selected to provide a maximum working radius, and when two cranes are being used on the same site, mast heights and jib lengths shall be considered.

Cranes should typically be structured around two rails at their base between 4.5 m and 10 m apart with wheels in each corner. Cranes should not normally be tied down, so sufficient kentledge should be provided so as to ensure that vertical loading from the crane passes through the rails and into the foundation. The foundation shall be so designed that the unfactored loading from the crane and the unfactored pressure is less than the allowable bearing pressure of the soil. Various foundation types can be selected depending on the ground conditions. Where possible a structural fill can be compacted and used to support a crane with the load spreading through layers of track support at 45° in to the soil strata below. When loads from the crane increase, reinforced concrete foundations may be required. This can involve a series of reinforced concrete beams used to support line loads as a result of the crane loading.

When ground conditions are particularly poor, pile foundations may be necessary. The design shall ensure that reinforcement at the top of the pile top should not cause problems for positioning the mast base section of the crane.

Tower cranes shall embody all fundamental principles of design in accordance with the **Suffix [7(16)]** so as to secure reliability and safety in operation. The particular requirements for controls for tower cranes and the arrangement of basic control used for positioning loads shall be in accordance with the **Suffix [7(17)].**

7.2.8.4 Falsework

Falsework involves a temporary structure used to support other permanent structures until they can support themselves. Falsework shall be designed and erected in accordance with the **Suffix [7(18)].**

7.2.8.5 Formwork

Formwork is the term used for a temporary mould into which concrete is poured and formed. Traditional formwork is fabricated using timber, but it can also be constructed from steel, glass fiber reinforced plastics and other materials.

Timber formwork is normally constructed on site using timber and plywood. It is easy to produce, although it can be time consuming for larger structures. Re-usable plastic formwork is generally used for quick pours of concrete. The formwork is assembled either from interlocking panels or from a modular system and is used for relatively simple concrete structures. It is not as versatile as timber formwork due to the prefabrication requirements and is best suited for low cost, repetitive structures such as mass housing schemes.

Stay-in-place structural formwork is generally assembled on site using prefabricated fibre-reinforced plastic. It is used for concrete columns and piers and stays in place, acting as permanent axial and shear reinforcement for the structural member. It also provides resistance to environmental damage to both the concrete and reinforcing bars. Proprietary systems are used to support vertical formwork while concrete cures, consisting of series of tubes and ties.

When selecting formwork the type of concrete and temperature of the pour are important considerations as they both effect the pressure exerted on the formwork.

High quality workmanship & inspection are necessary to ensure a high standard of work including finish.

7.2.8.6 Trench Support

A trench is defined as an excavation when its length greatly exceeds its depth. Shallow trenches are usually considered to be less than 6 m deep and deep trenches have depth greater than 6 m. Depending on the dimensions of a trench, excavation can either be carried out by hand or by using a mechanical digger. Trenches are commonly required to allow services, pipelines or foundations to be laid.

Water ingress into the trench is often a major issue and ground water table locations and soil strata should be investigated before any extensive excavation takes place. Over short periods of

time, for relatively shallow depths most soil types will stand almost vertically without any problems. However, trenches other than those which are relatively shallow may require a trench support scheme. Traditionally, trenching involved using timber to support horizontal and vertical soil loads and this technique is still used today. Timber trenching is generally used for low risk, narrow trenches, shafts or headings. The timber solutions require good workmanship and are reasonably labour intensive; however, they are versatile and the equipment required is easy to handle and transport.

Trench boxes are suitable for low-risk situations in stable, dry ground and can be placed in pre-excavated trenches or installed using the 'dig and push' technique. The system requires at least two struts at each panel for stability which should be considered when access is required for construction work or piping.

Trench sheets are the most adaptable of the systems available, and are most commonly used to retain poorer soil. They can support deeper trenches with larger surcharges and provide a continuous support. They require multiple levels of strut support and the slenderness of the sheets can often limit the depth of the trench as they are installed by light machinery and could buckle under large vertical loads.

While making deep excavation near an existing structure, it is necessary that the lateral force caused by the existing structure should be taken care of.

Trench supports shall be provided in accordance with the **Suffix [7(19)].**

7.2.9 Storage, Stacking and Handling of Practices

7.2.9.1 Planning and Storage Layout

a) For any site, there should be proper planning of the layout for stacking and storage of different materials, components and equipment with proper access and proper maneuverability of the vehicles carrying the material. While planning the layout, the requirements of various materials, components and equipment at different stages of construction shall be considered.

b) Materials shall be segregated as to kind, size and length and placed in neat, orderly piles that are safe against falling. If piles are high they shall be stepped back at suitable intervals in height. Piles of materials shall be arranged so as to allow a passageway of not less than 1 m width in between the piles or stacks for inspection or removal. All passageways shall be kept clear of dry vegetation.

c) Materials shall be stored, stacked and handled in such a manner as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.

d) Materials shall be stacked on well drained, firm and unyielding surface. Materials shall not be stacked so as to impose any undue stresses on walls or other structures.

e) Materials shall be stacked in such a manner as not to constitute a hazard to passerby. At such places the stacks shall have suitable warning signs in day time and red lights on and around them at night.

f) Stairways, passageways and gangways shall not become obstructed by storage of building materials, tools or accumulated rubbish.

7.2.9.2 Protection Against Atmospheric Agencies

Materials stored at site, depending upon the individual characteristics, shall be protected from atmospheric actions, such as rain, sun, winds and moisture, to avoid deterioration.

7.2.9.3 Protection Against Fire and Other Hazards

a) Materials, like timber, bamboo, coal, paints, etc, shall be stored in such a way that there may not be any possibility of fire hazards. Inflammable materials like kerosene and petrol, shall be stored in accordance with the relevant rules and regulations so as to

ensure the desired safety during storage. Stacks shall not be piled so high as to make them unstable under fire fighting conditions and in general they shall not be more than 4.5m in height. The provisions given in **Suffix [7(20)].**

b) Materials which are likely to be affected by subsidence of soil like precast beams, slabs and timber of sizes shall be stored by adopting suitable measures to ensure unyielding supports.

c) Materials liable to be affected by floods, tides, etc shall be suitably stored to prevent their being washed away or damaged due to floods, tides, etc.

7.2.9.4 Manual Handling

When heavy materials have to be handled manually each workman shall be instructed by his foreman or supervisor for the proper method of handling such materials. Each workman shall be provided with suitable equipment for his personal safety as necessary. All workers shall wear adequate clothing to protect themselves from direct sun-rays and other irritants. Supervisors shall also take care to assign enough men to each such job depending on the weight and the distance involved.

7.2.10 Storage, Stacking and Handling of Materials

7.2.10.1 General

The storage, stacking and handling of materials generally used in construction shall be as given in 7.2.10.2 to 7.2.10.31, which have been summarized in the form of a check list in **Annex A**. Exposure to asbestos fibers/ dust is known to be harmful to health of human beings.

7.2.10.2 Cement

a) Storage and stacking - Cement shall be stored at the work site in a building or a shed which is dry, leak proof and as moisture-proof as possible. The building or shed for storage should have minimum number of windows and close fitting doors and these should be kept closed as far as possible.

Cement received in bags shall be kept in such a way that the bags are kept free from the possibility of any dampness or moisture coming in contact with them. Cement bags shall be stacked off the floor on wooden planks in such a way as to keep them about 150 mm to 200 mm clear above the floor. The floor may comprise lean cement concrete or two layers of dry bricks laid on a well consolidated earth. A space of 600 mm minimum shall be left around between the exterior walls and the stacks (see Fig. 3). In the stacks the cement bags shall be kept close together to reduce circulation of air as much as possible. Owing to pressure on bottom layer of bags sometimes “warehouse pack” is developed in these bags. This can be removed easily by rolling the bags when cement is taken out for use. Lumped bags, if any should be removed and disposed of.

The height of stack shall not be more than 10 bags to prevent the possibility of lumping up under pressure. The width of the stack shall be not more than four bags length or 3 m. In stacks more than 8 bags high, the cement bags shall be arranged alternately length-wise and cross-wise so as to tie the stacks together and minimize the danger of toppling over. Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received; a table showing date of receipt of cement shall be put on each stack to know the age of cement.

For extra safety during monsoon, or when it is expected to store for an unusually long period, the stack shall be completely enclosed by a water proofing membrane such as polyethylene, which shall close on the top of the stack. Care shall be taken to see that the waterproofing membrane is not damaged any time during the use.

Cement in gunny bags, paper bags and polyethylene bags shall be stored separately. In case cement is received in drums, these shall be stored on plane level ground, as far as possible near the concrete mixing place. After taking out the required quantity of cement, the lid of the drum shall be securely tied to prevent ingress of moisture.

In case cement is received in silos, the silos shall be placed near the concrete batching plant. Proper access shall be provided for the replacement of silos.

Different types of cements shall be stacked and stored separately.

b) Handling - Hooks shall not be used for handling cement bags unless specifically permitted by the engineer-in-charge. Bags shall be removed uniformly from the top of the piles to avoid tipping of the stack. For information regarding bulk handling of cement (see 7.2.10.4).

7.2.10.3 Lime

7.2.10.3.1 Quicklime before slaking

a) Storage and stacking - Quicklime should be slaked as soon as possible. If unavoidable it may be stored in compact heaps having only the minimum of exposed area. The heaps shall be stored on a suitable platform and covered to avoid direct contact with rain or being blown away by wind. In case quick lime is stored in a covered shed, a minimum space of 300 mm should be provided all-round the heaps to avoid bulging of walls. Unslaked lime shall be stored in a place inaccessible to water and because of fire hazards, shall be segregated from the combustible materials.

b) Handling - See 7.2.10.4.

7.2.10.3.2 Hydrated lime

a) Storage and stacking - Hydrated lime is generally supplied in containers, such as jute bags lined with polyethylene or craft paper bags. It should be stored in a building to protect the lime from dampness and to minimize warehouse deterioration. The building should be with a concrete floor and having least ventilation to eliminate draughts through the walls and roof.In general, the recommendations given in 7.2.2 for storing of cement shall be applicable for hydrated lime. When air movement is reduced to a practical minimum, hydrated lime can be stored for up to three months without appreciable change.

b) Handling - See 7.2.10.4.

7.2.10.3.3 Dry slaked lime

a) Storage and stacking - The lime shall be stored in a dry and closed godown.

b) Handling - See 7.2.10.4.

7.2.10.4 Handling of Cement and Lime

Workers, handling bulk cement or lime shall wear protective clothing, respirators, and goggles; shall be instructed in the need of cleanliness to prevent dermatitis, and shall be provided with hand cream, petroleum jelly, or similar preparation for protection of exposed skin.

Workers handling cement, who are continually exposed to it, shall, in addition to the above be equipped with hand gloves and dust mask. Bulk cement stored in silos or bins may fail to feed to the ejection system. When necessary to enter a silo or bin for any purpose, the ejection system employed shall be shut down and locked out electrically as well as mechanically. When necessary for a workman to enter such storage area, he shall wear a life-line, with another workman outside the silo or hopper attending the rope.

7.2.10.5 Masonry Units

a) Stones - Stones of different sizes, types andclassification shall be stored separately. Stones shall be stacked on dry firm ground in a regular heap not more than 1 m in height. Veneering stones shall be stacked against vertical support on a firm dry ground in tiers, upto a height of 1.2 m. A distance of about 0.8 m shall be kept between two adjacent stacks.

b) Bricks - Bricks shall be stacked in regular tiers as and when they are unloaded to minimize breakage and defacement. These shall not be dumped at site. In the case of bricks made from clays containing lime Kankar, the bricks in stack should be thoroughly soaked in water (docked) toprevent lime bursting. Bricks shall be stacked on dry firm ground. For proper inspection of quality and ease in counting, the stacks shall be 50 bricks long, 10 bricks high and not more than 4 bricks in width, the bricks being placed on edge, two at a time along the width of the stack. Clear distance between adjacent stacks shall not be less than 0.8 m. Bricks of each truck load shall be put in one stack. Bricks of different types, such as, clay bricks, clay fly ash bricks, fly ash lime bricks, sand lime (calcium silicate) bricks shall be stacked separately. Bricks of different classifications from strength consideration and size consideration (such as, conventional and modular) shall be stacked separately. Also bricks of different types, such as, solid, hollow and perforated shall be stacked separately.

c) Blocks - Blocks are available as hollow and solid concrete blocks, hollow and solid light weight concrete blocks, autoclaved aerated concrete blocks, concrete stone masonry blocks and soil based blocks. Blocks shall be unloaded one at a time and stacked in regular tiers to minimize breakage and defacement. These shall not be dumped at site. The height of the stack shall not be more than 1.2 m, the length of the stack shall not be more than3.0 m, as far as possible and the width shall be of two or three blocks. Normally blocks cured for 28 days only should be received at site. In case blocks cured for less than 28 days are received, these shall be stacked separately. All blocks should be water cured for 10 to 14days and air cured for another 15 days; thus no blocks with less than 28 days curing shall be used in building construction. Blocks shall be placed close to the site of work so that least effort is required for their transportation. The date of manufacture of the blocks shall be suitably marked on the stacks of blocks manufactured at factory or site.

d) Handling - Brick stacks shall be placed close to the site of work so that least effort is required to unload and transport the bricks again by loading on pallets or in barrows. Unloading of building bricks or handling in any other way likely to damage the corners or edges or other parts of bricks shall not be permitted.

7.2.10.6 Floors, Wall and Roof Tiles

a) Storage and stacking- Floor, wall and clay roof tiles of different types, such as, cement concrete tiles (plain, coloured and terrazzo) and ceramic tiles (glazed and unglazed) shall be stacked on regular platform as far as possible under cover in proper layers and in tiers and they shall not be dumped in heaps. In the stack, the tiles shall be so placed that the mould surface of one faces that of another. Height of the stack shall not be more than 1.0 metre.Tiles of different quality, size and thickness shall be stacked separately to facilitate easy removal for use in work. Tiles when supplied by manufacturers packed in wooden crates shall be stored in crates. The crates shall be opened one at a time as and when required for use.

b) Handling - Ceramic tiles and roof tiles are generally supplied in cartons which shall be handled with care to avoid breakage. It is preferable to transport these at the site on platform trolleys.

7.2.10.7 Aggregate

a) Storage and stacking - Aggregates shall be stored at site on a hard dry and level patch of ground. If such a surface is not available, a platform of planks or old corrugated iron sheets, or a floor of bricks, or a thin layer of lean concrete shall be made so as to prevent the mixing with clay, dust, vegetable and other foreign matter.Stacks of fine and coarse aggregate shall be kept in separate stock piles sufficiently removed from each other to prevent the material at the edges of the piles from getting intermixed. On a large job it is desirable to construct dividing walls to give each type of aggregates its own compartment. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum.

b) Handling - When withdrawals are made from stock piles, no overhang shall be permitted. Employees required to enter hoppers shall be equipped with safety belts and life-lines, attended by another person. Machine driven hoppers, feeders, and loaders shall be locked in the off position prior to entry, electrically as well as mechanically.

7.2.10.8 Pulverized Fuel Ash/Fly Ash/Silica

a) Storage and stacking - Fly ash/**Silica fume** shall be stored in such a manner as to permit easy access for proper inspection and identification of each consignment. Fly ash in bulk quantities shall be stored in stack similar to fine aggregates, avoiding any intrusion of foreign matter. Fly ash in bags shall be stored in stacks not more than 10 bags high. Silica fume, in general, shall be stored similar to cement/fly ash storage depending upon the storage requirements in bags/bulk form.

b) Handling – See 7.2.10.4.

7.2.10.9 Cinder

Cinder shall be stored in bulk quantities in stacks similar to coarse aggregates avoiding any extrusion of foreign matter.

7.2.10.10 Timber

a) Storage and stacking - Timber shall be stored in stacks upon well treated and even surfaced beams, sleepers or brick pillars so as to be above the ground level by at least 150 mm to ensure that the timber will not be affected by accumulation of water under it. Various members shall preferably be stored separately in different lengths, and material of equal lengths shall be piled together in layers with wooden battens, called crossers, separating one layer from another. The crossers shall be of sound wood, straight and uniform in thickness. In case, where separate crossers are not available smaller sections of the available structural timber may be employed in their place. In any layer an air space of about 25 mm shall be provided between adjacent members. The longer pieces shall be placed in the bottom layers and shorter pieces in the top layers but one end of the stack shall be in true vertical alignment. The crossers in different layers shall be in vertical alignment. The most suitable width and height of a stack are recommended to be about 1.5 m and 2.0 m. Distance between adjacent stacks is recommended to be at least 450 mm.

In case the stacking with the help of battens is not possible, the timber may be close piled in heaps on raised foundations with the precautions specified above.The stacks shall be protected from hot dry winds or direct sun and rain. Heavy weights, such as metal rails or large sections of wood, are recommended to be placed on the top of the stack to prevent distortion or warping of the timber in the stack. In case timber is to be stored for about a year or more, to prevent end-cracking in the material, the ends of all members shall be coated with coal tar, aluminium leaf paints (hardened gloss oil), microcrystalline wax or any other suitable material.

b) Care must be taken that handler or workers are not injured by rails, straps, etc, attached to the used timber. This applies particularly to planks and formwork for shuttering.

7.2.10.11 Bamboo

a) The site shall be properly inspected and termite colonies or mounds, if detected, shall be destroyed. All refuse and useless cellulosic materials shall be removed from the site. The ground may then be disinfected by suitable insecticides. The area should have good drainage.

b) Bamboo may preferably be stacked on high skids or raised platform at least 300 mm above ground. Storage under cover reduces the liability to fungal attack. Good ventilation and frequent inspection are important.

c) Bamboo dries by air-seasoning under cover in the storage yards from 6 to 12 weeks time.

d) Prophylactic treatment of bamboo during storage prevents losses due to fungi and insects even under open storage. Following chemicals have been found suitable at a coverage rate of 24 litre per tonne:

1. Sodium pentachlorophenate : 1 percent solution.
2. Boric acid + borax (1:1) : 2 percent solution.
3. Sodium pentachlorophenate : 2.5 percent solution + boric acid + borax (5:1:1).

A mixture of these compounds yields the best results.

NOTE - For better protection of structural bamboo (if stored outside), repetition of the treatment after four to six months is desirable.

7.2.10.12 Partially Prefabricated Wall and Roof Components

a) Storage and stacking- The wall components comprise blocks, sills, lintels, etc. The blocks shall be stacked in accordance with 7.2.10.5(c) These shall be stacked on plane level ground having a floor of bricks or a thin layer of lean concrete.The roof components such as precast RC joists, prefabricated brick panels, RC planks, channel units, cored units, waffle units, L-panel, single tee and double tee sections, ferrocement panels, etc shall be unloaded as individual components. These shall be stacked on plane level ground having a floor of bricks or a thin layer of lean concrete. RC planks, prefabricated brick panels and ferrocement panels shall be stacked against a brick masonry wall in slightly inclined position on both sides of the wall. Channel units, cored units and L-panels shall be stacked one over the other up to five tiers. The waffle units shall be stacked upside down as individual units. The RC joists, single tee and double tee sections shall be stacked as individual units one adjacent to the other. The distance between any two adjacent stacks shall not be less than 450 mm.

b) Handling - The components shall be handled by holding the individual components at specified points so that the stresses due to handling are minimized.

7.2.10.13 Steel

a) Storage and stacking - For each classification of steel, separate areas shall be earmarked. It is desirable that ends of bars and sections of each class be painted in distinct separate colours. Steel reinforcement shall be stored in a way as to prevent distortion and corrosion. It is desirable to coat reinforcement with cement wash before stacking to prevent scaling and rusting.

Bars of different classification, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths as to minimize wastage in cut from standard lengths.

In case of long storage or in coastal areas, reinforcement bars shall be stacked above ground level by at least 150 mm and a coat of cement wash shall be given to prevent scaling and rusting.

Structural steel of different sections, sizes and lengths shall be stored separately. It shall be stored above ground level by at least 150 mm upon platforms, skids or any other suitable supports to avoid distortion of sections. In case of coastal areas or in case of long storage, suitable protective coating of cement wash shall be given to prevent scaling and rusting.

b) Handling -Tag lines shall be used to control the load in handling reinforcements or structural steel when a crane is employed Heavy steel sections and bundles shall be lifted and carried with the help of slings and tackles and shall not be carried on the shoulders of the workers.

7.2.10.14 Aluminium Sections

a) Storage and stacking - Aluminium sections of different classification, sizes and lengths shall be stored separately, on a level platform under cover.

b) Handling - The aluminium sections shall not be pulled or pushed from the stack nor shall be slid over each other, to protect the anodizing layer.

7.2.10.15 Doors, Windows and Ventilators

a) Storage and stacking - Metal and plastic doors, windows and ventilators shall be stacked upright (on their sills) on level groundpreferably on wooden battens and shall not come in contact with dirt or ashes. If received in crates they shall be stacked according to manufacturer's instructions and removed from the crates as and when required for the work. Metal and plastic frames of doors, windows and ventilators shall be stacked upside down with the kick plates at the top. These shall not be allowed to stand for long in this manner before being fixed so as to avoid the door frames getting out of shape and hinges being strained and shutters drooping.

During the period of storage of aluminium doors, windows and ventilators, these shall be protected from loose cement and mortar by suitable covering, such as tarpaulin. The tarpaulin shall be hung loosely on temporary framing to permit circulation of air to prevent moisture condensation.

All timber and other lignocellulosic material-based frames and shutters shall be stored in a dry and clean covered space away from any infestation and dampness. The storage shall preferably be in well-ventilated dry rooms. The frames shall be stacked one over the other in vertical stacks with cross battens at regular distances to keep the stack vertical and straight. These cross battens should be of uniform thickness and placed vertically one above the other. The door shutters shall be stacked in the form of clean vertical stacks one over the other and at least 80 mm above ground on pallets or suitable beams or rafters. The top of the stack shall be covered by a protecting cover and weighted down by means of scantlings or other suitable weights. The shutter stack shall rest on hard and level surface.

If any timber or other lignocellulosic material-based frame or shutter becomes wet during transit, it shall be kept separate from the undamaged material. The wet material may be dried by stacking in shade with battens in between adjacent boards with free access of dry air. Separate stacks shall be built up for each size, each grade and each type of material. When materials of different sizes, grades and types are to be stacked in one stack due to shortage of space, the bigger size shall be stacked in the lower portion of the stacks. Suitable pallets or separating battens shall be kept in between the two types of material.Precast concrete door and window frames shall be stored in upright position adopting suitable measures against risk of subsidence of soil/support.

b) Handling-While unloading, shifting, handling and stacking timber or other lignocellulosic material based, metal and plastic door and window frames and shutters, care shall be taken that the pieces are not dragged one over the other as it may cause damage to their surface particularly in case of the decorative shutters.The pieces should be lifted and carried preferably flat avoiding damage to corners or sides.

7.2.10.16 Roofing Materials

7.2.10.16.1 Roofing sheets shall be stored and stacked in such a manner as not to damage them in any way.

Damaged sheets shall not be stacked with sound materials. All damaged sheets shall be salvaged as early as possible.

7.2.10.16.2 Asbestos cement sheet

a) Storage and stacking - Asbestos cement sheets shall be stacked horizontally to a height of not more than 1m on a firm and level ground, with timber or other packing beneath them. If stacked in exposed position, they shall be protected from damage by wind. Asbestos cement sheets of same variety and size shall be stacked together.

b) Handling -Not more than two sheets shall be first pushed forward along the valley line say about one fourth of the sheet length and preferably carried by two workers. Asbestos cement sheets shall be lowered or raised gently and not thrown.

7.2.10.16.3 Corrugated Galvanized Iron Sheets (CGI) and aluminium sheets

a) Storage and stacking -Corrugated galvanized iron (CGI) sheets and aluminium sheets shall be stacked horizontally to a height of not more than 0.5 m on a firm and level ground, with timber or other packing beneath them. To protect them from dust and rain water, these shall be covered with tarpaulin or polyethylene sheets.

b) Handling - In bulk handling of CGI sheets, workers shall be provided with suitable hand protection.

7.2.10.16.4 Plastic sheets and glass reinforced plastic (GRP) sheets

a) Storage and stacking - Plastic sheets and glass reinforced plastic (GRP) sheets shall be stacked under a shed to a height of not more than 0.5 m on a firm and level ground with timber or other packing beneath them.

b) Handling - Handling shall be done to avoid any damage to the sheets.

7.2.10.17 Boards

7.2.10.17.1 Gypsum boards

a) Storage and stacking - Gypsum boards shall be stored flat in a covered clean and dry place.

b) Handling - See 7.2.10.17.2(b)

7.2.10.17.2 Plywood, fibre board, particle board, block board, etc

a) Storage and stacking - Plywood, fibre board, particle board, block board, etc, shall not be stored in the open and exposed to direct sun and rain. The boards shall be stacked on a flat dunnage, on the top of which a wooden frame shall be constructed with battens of 50 mm × 25 mm (Min) in such a way that it supports all four edges and corners of the boards with intermediate battens placed at suitable intervals to avoid warping. If required, the stack shall be adequately raised above ground level to ensure that it will not be affected by accumulation of water under it. The board shall be stacked in a solid block in a clear vertical alignment. The top sheet of each stack shall be suitably weighed down to prevent warping, wherever necessary.

b) Handling - The board shall be unloaded and stacked with utmost care avoiding damage to the corners and surface. In case of decorative plywood and decorative boards, the surfaces of which are likely to get damaged by dragging one sheet over another, it is advisable that these are lifted as far as possible in pairs facing each other.

7.2.10.18 Plastic and Rubber Flooring Sheets and Tiles

a) Storage and stacking - Plastic and rubber sheets have tendency to break-down during storage. Plastic and rubber sheets shall be stored according to manufacturer's instructions. The coolest store room available shall be utilized for the storage of the sheets. The store rooms where the sheets are stored shall be well ventilated and direct light should not be allowed to fall on them.

The sheets shall be stored away from electric generators, electric motors, switchgears and other such electrical equipment as they produce harmful odour/gases. Contamination of the sheets with vegetable and mineral oils; greases; organic solvents; acids and their fumes; alkalies; dust and grit shall be prevented. Where greasy contamination occurs, this shall be removed immediately with petrol and the sheets and tiles thoroughly wiped dry and dusted with chalk.

Undue stretch and strain, kinks, sharp bends or folds of the sheets and tiles shall be avoided. In case of long storage, the sheets shall be turned over periodically and treated with chalk powder, if necessary.

c) **Handling** - While handling plastic and rubber sheets, workers shall lift the sheets and carry them flat to avoid sharp bends or folds of the sheets.

7.2.10.19 Glass Sheets

a) Storage and stacking - The special glasses shall be stored and handled as per manufacturer's instructions.

It is important that all glass sheets whether stored in crates or not shall be kept dry. Suitable covered storage space shall be provided for the safe storage of the glass sheets. The glass sheets shall be lifted and stored on their long edges and shall be put into stacks of not more than 25 panes, supported at two points by fillets of wood at about 300 mm from each end. The first pane laid in each stack shall be so placed that its bottom edge is about 25 mm from the base of the wall or other support against which the stack rests. The whole stack shall be as close and as upright as possible. To prevent slipping on smooth floor, the floor shall be covered with gunny bags. The glass sheets of different sizes, thickness and type shall be stacked separately. The distance between any two stacks shall be of the order of 400 mm.

b) Handling - Workers handling glass panes, waste glass pieces and fibre glass shall be provided with suitable hand protection. In removing glass sheets from crates, due care shall be taken to avoid damages. Glass edges shall be covered or otherwise protected to prevent injuries to workers. Special glasses shall be stored and handled as per manufacturer's instructions.

7.2.10.20 Cast Iron, Galvanized Iron and Asbestos Cement Pipes and Fittings

a) Storage and stacking - The pipes shall be unloaded where they are required, when the trenches are ready to receive them. Storage shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes placed lengthwise and crosswise in alternate layers. The pyramid stack is advisable in smaller diameter pipes for conserving space in storing them. The height of the stack shall not exceed 1.5 m. Each stack shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars or suppliers wherever possible.

Cast iron detachable joints and fittings shall be stacked under cover and separated from the asbestos cement pipes and fittings. Rubber rings shall be kept clean, away from grease, oil, heat and light.

b) Handling - Pipes in the top layer shall be handled first. At a time only one pipe shall be handled by two labourers while carrying to the actual site and shall be carried on shoulders. Fittings shall be handled individually.

7.2.10.21 Polyethylene Pipes

a) Storage and stacking — Black polyethylene pipes may be stored either under cover or inthe open. Natural polyethylene pipes, however, should be stored under cover and protected from direct sunlight.Coils may be stored either on edge or stacked flat one on top of the other, but in either case they should not be allowed to come into contact with hot water or steam pipes and should be kept away from hot surface. Straight lengths should be stored on horizontalracks giving continuous support to prevent the pipe taking on a permanent set. Storage of pipes in heated areas exceeding 27°C should be avoided.

b) Handling -Removal of pipe from a pile shall be accomplished by working from the ends of the pipe.

7.2.10.22 Unplasticized PVC Pipes

a) Storage and stacking - Pipes should be stored on a reasonably flat surface free from stones and sharp projections so that the pipe is supported throughout its length. The pipe should be given adequate support at all times. In storage, pipe racks should be avoided. Pipe should not be stacked in large piles especially under warm temperature conditions as the bottom pipes may distort thus giving rise to difficulty in jointing. Socket and spigot pipes should be stacked in layers with sockets placed at alternate ends of the stacks to avoid lopsided stacks.

It is recommended not to store a pipe inside another pipe. On no account should pipes be stored in a stressed or bend condition or near a source of heat. Pipes should not be stacked more than 1.5 m high. Pipes of different sizes and classes should be stacked separately. In tropical conditions, pipes should be stored in shade. In very cold weather, the impact strength of PVC is reduced making it brittle. The ends of pipe should be protected from abrasion particularly those specially prepared for jointing either spigot or socket solvent welded joints or soldered for use with couplings.

If due to unsatisfactory storage or handling, a pipe becomes kinked, the damaged portion should be cut out completely. Kinking is likely to occur only on very thin walled pipes.

b) Handling - Great care shall be exercised in handling these pipes in wintry conditions as these become brittle in very cold weather.

7.2.10.23 Pipes of Conducting Materials

a) Storage and stacking - Pipes shall be stacked on solid level sills and contained in a manner to prevent spreading or rolling of the pipe.Where quantity storage is necessary, suitable packing shall be placed between succeeding layers to reduce the pressure and resulting spreading of the pile.In stacking and handling of pipes and other conducting materials, the following minimum safety distances shall be ensured from the overhead power lines:

11 kV and below :	1.40 m
Above 11 and below 33 kV :	3.60 m
Above 33 and below 132 kV :	4.70 m
Above 132 and below 275 kV :	5.70 m
Above 275 and below 400 kV :	6.50 m

b) Handling - Removal of pipes from a pile shall be accomplished by working from the ends of the pipe. During transportation, the pipes shall be so secured as to ensure against displacement.

7.2.10.24 Piles and Poles

a) Storage and stacking - Piles and poles shall be carefully stacked on solid, level sills so as to prevent rolling or spreading of the pile. The storage area shall be maintained free of vegetation and flammable materials.

b) Handling -When placing piles or poles on the stack, workers shall work from the ends of the piles/poles. Similar precautions shall be observed in removal of piles/poles from the stack. Tag lines shall be used to control piles and poles when handling for any purpose.In stacking and handling of piles and poles, precautions as laid down in 7.2.10.18(a) shall be followed.

7.2.10.25 Paints, Varnishes and Thinners

a) Storage and stacking - Paints, varnishes, lacquers, thinners and other flammable materials shall be kept in properly sealed or closed containers. The containers shall be kept in a well ventilated location, free from excessive heat, smoke, sparks or flame. The floor of the paint stores shall be made up of 100 mm thick loose sand. Paint materials in quantities other than required for daily use shall be kept stocked under regular storage place. Where the paint is likely to deteriorate with age, the manner of storage shall facilitate removal and use of lots in the same order in which they are received.

Temporary electrical wirings/fittings shall not be installed in the paint store. When electric lights, switches or electrical equipment are necessary, they shall be of explosion proof design.

b) Handling - Adequate ventilation to prevent the accumulation of flammable vapours to hazardous levels of concentration shall be provided in all areas where painting is done.When painting is done in confined spaces where flammable or explosive vapours may develop, any necessary heat shall be provided through duct work remote from the source of flame.

Sources of ignition, such as open flame and exposed heating elements, shall not be permitted in area or rooms where spray painting is done nor shall smoking be allowed there.

Care should be taken not to use any naked flame inside the paint store. Buckets containing sand shall be kept ready for use in case of fire. Fire extinguishers when required shall be of foam type conforming to accepted **Suffix [7(21)]** {see also **Suffix [7(22)]}.** Each workman handling lead based paints shall be issued ½ litre milk per day for his personal consumption.

7.2.10.26 Bitumen, Road Tar, Asphalt, etc

a) Storage and stacking - Drums or containers containing all types of bitumen, road tar, asphalt, etc, shall be stacked vertically on their bottoms in up to 3 tiers. Leaky drums shall be segregated.

Empty drums shall be stored in pyramidal stacks neatly in rows.

7.2.10.27 Bituminous Roofing Felts

a) Storage and stacking -Bituminous roofing felts shall be stored away from other combustible materials and shall be kept under shade.

b) Handling- Bituminous roofing felts should be handled in a manner to prevent cracking and other damages.

7.2.10.28 Flammable Materials

a) Storage and stacking - In addition to the requirements as laid down in 7.2.9.3 the following provisions shall also apply:

1) Outdoor storage of drums requires some care to avoid contamination because moisture and dirt in hydraulic brake and transmission fluid, gasoline, or lubricants may cause malfunction or failure of equipment, with possible danger to personnel. The storage area should be free of accumulations of spilled products, debris and other hazards.

2) Compressed gases and petroleum products shall not be stored in the same building or close to each other. Storage of petroleum products should be as per Petroleum Rules, 2002, as amended from time-to-time.

b) Handling - Petroleum products delivered to the job site and stored there in drums shall be protected during handling to prevent loss of identification through damage to drum markings, tags, etc. Unidentifiable petroleum products may result in improper use, with ossible fire hazard, damage to equipment or operating failure.

Workers shall be required to guard carefully against any part of their clothing becoming contaminated with flammable fluids. They shall not be allowed to continue work when their clothing becomes so contaminated.

7.2.10.29 Water

Water to be stored for construction purposes shall be stored in proper tanks to prevent any ingress of organic impurities. The aggregate capacity of storage tanks shall be determined after taking into account the requirements of firefighting.

7.2.10.30 Sanitary Appliances

a) Storage and stacking - All sanitary appliances shall be carefully stored under cover to prevent damage. When accepting and storing appliances, consideration shall be given to the sequence of removal from the store to the assembly positions. Vitreous fittings shall be stacked separately from the metal ones.

b) Handling - Bigger sanitary appliances shall be handled one at a time. Traps, water seals and gullies shall be handled separately. While handling sanitary fittings they shall be free from any oil spilling, etc. The hands of the workers shall also be free from any oily substance. Before lowering the appliances in their position the supporting brackets,pedestals, etc, shall be checked for their soundness and then only the fixtures be attached.

7.2.10.31 Other Materials

Polymeric materials such as coatings, sheeting, reflective surfacing/sheeting, etc, shall be stored as per the manufacturer's instructions. Special precautions shall be taken in case of storage, handling and usage of toxic materials.

Small articles like screws, bolts, nuts, door and window fittings, polishing stones, protective clothing, spare parts of machinery, linings, packings, water supply and sanitary fittings, and electrical fittings, insulation board, etc, shall be kept in suitable and properly protected containers or store rooms. Valuable small materials shall be kept under lock and key.

7.2.10.32 Special Considerations

a) Materials constantly in use shall be relatively nearer to the place of use.
b) Heavy units like precast concrete members shall be stacked near the hoist or the ramp.
c) Materials which normally deteriorate during storage shall be kept constantly moving, by replacing old materials with fresh stocks. Freshly arrived materials shall never be placed over materials which had arrived earlier.
d) Appropriate types of fire extinguishers shall be provided at open sites where combustible materials are stored and for each storage shed/room where flammable/combustible materials are stored. For guidance regarding selection of the appropriate types of fire extinguishers reference may be made to **Suffix [7(22)]**. It is desirable that a minimum of two extinguishers are provided at each such location.
e) Workers handling excavated earth from foundation, particularly if the site happens to be reclaimed area or marshy area or any other infected area, shall be protected against infection affecting their exposed body portions.
f) House keeping, Stairways, walkways, scaffolds, and access ways shall be kept free of materials, debris and obstructions. The engineer-in-charge/the foreman shall initiate and

carry out a programme requiring routine removal of scrap and debris from scaffolds and walkways.

g) Where stacking of the materials is to be done on road side berms in the street and other public place, the owner shall seek permission from the Authority for such stacking and also for removing the remnants of the same after the construction is over, so as to avoid any hazard to the public.

7.2.11 Unloading Rail/Road Wagons and Motor Vehicles

7.2.11.1 Loading and unloading from rail/road wagons

a) Appropriate warning signals shall be displayed to indicate that the wagons shall not be coupled or moved.
b) The wheels of wagons shall always be sprigged or chained while the wagons are being unloaded. The brakes alone shall not be depended upon.
c) Special level bars shall preferably be used for moving rail wagons rather than ordinary crow bars.
d) Where gangplanks are used between wagons and platforms of piles (heaps), cleats at lower end of gangplank, or pin through end of gangplanks, shall be used to prevent sliding. If gangplank is on a gradient, cleats or abrasive surface shall be provided for the entire length.
e) When rail/road wagons are being loaded or unloaded near passageways or walkways, adequate warning signals shall be placed on each end of the wagon to warn pedestrians.

7.2.11.2 Loading and Unloading from Motor Vehicles

a) The motor vehicles shall be properly blocked while being loaded or unloaded; brakes alone shall not be depended upon to hold them.
b) When motor vehicles are being loaded or unloaded near passageways or walkways, adequate warning signs shall be placed on each end of the vehicle to warn the pedestrians.
c) Adequate lighting shall be provided while loading/unloading.

7.2.11.3 Handling Heavy/Long Items

a) Loading and unloading of heavy items, shall, as far as possible, be done with cranes or gantries. The workman shall stand clear of the material being moved by mechanical equipment. The slings and the ropes used shall be of adequate load carrying capacity, so as not to give way and result in accidents.
b) While heavy and long components are being manually loaded into motor vehicle, wagons, trailer, etc, either wooden sleepers or steel rails of sufficient length and properly secured in position shall be put in a gentle slope against the body of the wagon/vehicle at 3 or 4 places for loading. These long items shall be dragged, one by one, gently and uniformly along these supports by means of ropes, being pulled by men with feet properly anchored against firm surface. As soon as the items come on the floor of the vehicle, the same may be shifted by crowbars and other suitable leverage mechanism, but not by hands to avoid causing accident to the workers.
c) Similar procedure as outlined under 7.2.11.3 (b)shall be followed for manual unloading of long or heavy items.

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7.3 SAFETY IN CONSTRUCTION OF ELEMENTS OF A BUILDING

7.3.1 GENERAL

a) The provisions of this Section shall apply to the erection/alteration of the various parts of a building or similar structure. The construction of the different elements shall conformed to 7.2.3.

b) ***Other Laws*** — Nothing herein stated shall be construed to nullify any rules, regulations, safety standards or statutes of the local state governments. The specific rules, regulations and acts pertaining to the protection of the public or workers from health and other hazards, wherever specified by the Local/State Authority or in the Acts of the Government take precedence over whatever is herein specified in case of a doubt or dispute.

c) Safety Management

1) The safety of personnel engaged in building construction should be ensured through a well planned and well organized mechanism for this, depending on the size and complexity of building construction project, safety committee shall be constituted to efficiently manage all safety related affairs. The site in-charge or his nominee of a senior rank shall head the committee and a safety officer shall act as member-secretary. The meetings of the safety committee shall be organized regularly say fortnightly or monthly depending on the nature of the project, however, emergency meetings shall be called as and when required. The safety committees shall deal with all the safety related issues through well structured agenda, in the meetings and all safety related measures installed at the site and implementation thereof shall be periodically reviewed.

2) Notwithstanding the guidelines given in 7.3.1, all provisions given in relevant Act / Rules / Regulations as amended from time to time shall be followed.

3) Health, Safety and Environment

Each project affects the safety and health of the workers and surroundings during construction, building maintenance and demolition. Various activities having impact on health, safety and environment need to be identified with their likely effect and proposed preventive corrective actions together with the concerned statutory obligation.

4) Policy

Every organization in the construction industry shall lay down the policy and establish, implement a management system that is safety and health of workers at premises of the project. When lay down the policy, all stakeholders (Regional authority, designer, developer, all personal implementing the project) shall participate and concerned with this policy including allocating budget for this.

5) Project Management

The project management shall establish documented objectives for relevant functions and levels within the organization. The objective shall measurable, specific, attainable relevant, timely and aligned with the policy, to prevent work related injury and ill health, to comply with the applicable legal and other requirements to which the organization subscribes and for continual improvement.

The responsibility, authority and interrelation of workers who manage, perform and verify work affecting safety and health shall be defined and documented. The person at each level of the organization shall assume responsibility for those aspects of the safety and health management system over which they have controlled. They also have to identify and manage existing and potential hazards to eliminate or minimize the risk of work related injury and occupational hazards.

All workers must be competence to perform their duties in a safe manner so that they were given the trainings, awareness and then recorded.

6) Safety meeting and permit to work

To inform and formally address issues and take appropriate action to achieve the worksite safety and health management system objectives, all groups in the worksite have to attend the meetings, and it shall be documented. Moreover, toolbox meetings are conducted at regular intervals within work groups to effectively communicate and coordinate work instructions and to promote safe conduct of work and safety briefings shall also be carried out regularly.

The safety procedures to ensure that all works are carried out in a safe and healthy manner to eliminate hazards and reduce risks. A "Permit-To-Work" (PTW) system is a formal documented safety procedures, it is a part of safety management system, and ensure that all necessary actions are taken before, during and after particularly for high-risk works.

7) Machinery and tools maintenance program

The project management shall take into consideration of a maintenance program to ensure the safe and efficient operation of plants, equipment, machinery and hand tools used at the worksite. They also manage health and well-being to approach views a healthy workplace as one that has workers and managers collaborating in a continual improvement process to protect and promote health and well-being of all workers.

8) Emergency plans

The project management shall establish "emergency plans" to respond to emergency situations. The plan shall be reviewed or tested regularly to ensure their effectiveness and suitability. They also shall establish and maintain documented procedures for inspection to ensure that unsafe conditions and practices at the worksite are identified and corrective actions are implemented promptly and effectively.

9) In-house safety rules and regulations

The "in-house safety rules and regulations" must be addressed to ensure that all workers know their obligations and responsibilities. The project management shall establish procedures to ensure that the in-house safety rules and regulations are communicated, implemented and enforced diligently at the worksite.

10) Incident investigation

The incident investigation and analysis to be done when an accident was occurred at worksite. It is an important tool for preventing the recurrence of incidents and identifying opportunities for improvements. The project management shall establish and maintain procedures to identify, record, investigate and analyse incidents with the objective of implementing specific corrective actions to prevent their recurrence.

Arrangements to conduct periodic audits are to be established in order to determine whether the safety and health management system and its elements are in place, adequate and effective in protecting the safety and health of workers and preventing incidents.

7.3.2 TERMINOLOGY

For the purpose of this Part the following definitions shall apply.

7.3.2.1 Authority Having Jurisdiction — The Authority which has been created by a statute and which for the purpose of administering the Code/Part, may authorize a committee or an official to act on its behalf; hereinafter called the ‘Authority’.

7.3.2.2 Construction Equipment — All equipment, machinery, tools and temporary retaining structures and working platforms, that is, tools, derricks, staging, scaffolds, runways, ladders and all material, handling equipment including safety devices.

7.3.2.3 Floor Hole — An opening measuring less than 300 mm but more than 25mm in its least dimension, in any floor, platform, pavement, or yard, through which materials but not persons may fall; such as, a belt hole, pipe opening or slot opening.

7.3.2.4 Floor Opening — An opening measuring 300 mm or more in its least dimension, in any floor, platform, pavement or yard through which person may fall; such as hatch way, stair or ladder opening, pit or large manhole.

7.3.2.5 Guard Railing — A barrier erected along exposed edges of an open side floor opening, wall opening, ramp, platform, or catwalk or balcony, etc, to prevent fall of persons.

7.3.2.6 Materials Handing Hoists — A platform, bucket or similar enclosure exclusively meant for the lifting or lowering of construction material the hoists being operated from a point outside the conveyance.

7.3.2.7 Pile Rig — The complete pile driving equipment comprising piling frame, leader, hammer, extractor winch and power unit. Complete pile driving rig may be mounted on rafts or pontoon or rails. Pile rig may also be a mobile unit mounted on trailers or trucks, or a special full revolving rig for raking piles.

7.3.2.8 Platform — A working space for persons, elevated above the surrounding floor or ground, such as balcony or platform for the operation of machinery and equipment.

7.3.2.9 Scaffold —A temporary erection of timber or metal work used in the construction, alteration or demolition of a building, to support or to allow the hoisting and lowering of workmen, their tools and materials.

7.3.2.10 Toe Board — A vertical barrier erected along exposed edge of a floor opening,wall opening, platform, catwalk or ramp to prevent fall of materials or persons.

7.3.2.11 Wall Hole — An opening in any wall or partition having height of less than 750 mm but more than 25 mm and width unrestricted.

7.3.2.12 Wall Opening — An opening in any wall or partition is having both height of at least 750 mm and width of at least 450 mm.

7.3.3 TEMPORARYCONSTRUCTION, USE OF SIDE WALLS AND TEMPORARY ENCROACHMENTS

7.3.3.1 Temporary Construction

The plans and specifications of temporary constructions, which are likely to interfere with facilities or right of way provided by the Authority, shall be submitted to the Authority for approval showing clearly the layout, design and construction.

Temporary structure shall apply to the following types of structures:

a) Structures with roof or walls made of straw, hay, ulugrass, golpatta, hogle, darma, mat, canvas cloth or other like materials not adopted for permanent or continuous occupancy.
b) Site-work sheds, truck-runways, trestles, footbridges, etc.

Fire safety requirements for temporary workers' quarters shall be complied with the provisions of Myanmar Fire Safety Code 2020.

7.3.3.2 For detailed information regarding fire safety aspects in respect of construction, location, maintenance and use of temporary structures reference may be made to **Suffix [7(23)]**.

7.3.3.3 Special permits shall be obtained for the storage of the materials on side walks and highways. It shall be ensured that the material dump or the storage shed does not create a traffic hazard, nor it shall interfere with the free flow of the pedestrian traffic. Special permits shall also be obtained for the use of water and electricity from the public facilities. Whenever such utilities

are made use of, adequate safety precautions regarding drainage and elimination of contamination and hazards from electricity shall be taken.

7.3.3.4 In order to ensure safety for the adjoining property, adequate temporary protective guards are to be provided. In case these protective devices project beyond the property, the consent of the Authority and that of the owner of the adjoining property shall be obtained.

7.3.4 TESTING

7.3.4.1 Tests

No structure, temporary support, scaffolding or any construction equipment during the construction or demolition of any building or structure shall be loaded beyond the allowable loads and working stresses as provided for in Structural Design **Suffix [7(24)].**

Whenever any doubt arises about the structural adequacy of a scaffolding, support or any other construction equipment, it shall be tested to two and a half times the superimposed dead and imposed loads to which the material or the equipment is subjected to and the member/material shall sustain the test load without failure if it is to be accepted.

7.3.4.2 Notwithstanding the test mentioned above, if any distress in any member is visible, the member shall be rejected.

7.3.5 INSPECTION AND RECTIFICATION OF HAZARDOUS DEFECTS

a) **Inspection —** The Authority shall inspect the construction equipment and if during the inspection, it is revealed that unsafe/illegal conditions exist, the Authority shall intimate the Project Manager and owner and direct him to take immediate remedial measures to remove the hazard/violation.

b) **Rectification —** The owner shall proceed to rectify the defect, hazardous condition or violation within 24 h of the receipt of the notice from the Authority. The Authority shall have full powers to rectify the unsafe condition and all expenses incurred in this connection is payable by the owner of the property. Illegal encroachments and non-payment of money due, in respect of the rectification of unsafe conditions may vest a lien on the property with the Authority.

c) When the strength and adequacy of any scaffold or other construction equipment is in doubt or when any complaint is made, the Authority shall get the same inspected before use.

7.3.6 FOUNDATIONS

7.3.6.1 General

The distribution of the supporting foundation shall be such as to avoid any harmful differential settlement of the structure. The type and design of the foundation adopted shall ensure safety to workmen during construction and residents of the neighbouring property. Sufficient care shall be taken in areas, where withdrawal of ground water from surrounding areas could result in damages to such foundations. During the construction of the foundation, it shall be ensured that the adjoining properties are not affected by any harmful effects.

7.3.6.2 Adjoining Properties

The person causing excavation shall, before starting the work, give adequate notices in writing to the owner of the adjoining properties, safety of which is likely to be affected due to excavation. After having given such notices, wherein details regarding the type of protective works that are anticipated to be incorporated in the excavation are shown, written permission shall be obtained for such excavation from the adjoining property owners. Where necessary, the person causing excavation shall make adequate provision to protect the safety of adjacent property. If on giving such notices and the precautionary measures having been approved by the Authority, the

adjoining property owner still refuses to give necessary facilities to the person causing excavation for protecting/providing both temporary and permanent supports to such property. the responsibility for any damage to the adjoining property shall be that of the adjoining property owner.

7.3.6.2.1 Protection To Neighboring Structures and Adjoining Services

In driven piles vibration is set up which may cause damage to adjoining structures or service lines depending on the nature of soil condition and the construction standard of such structures and service lines. Possible extent of all such damages shall be ascertained in advance, and operation and mode of driving shall be planned with appropriate measures to ensure safety. Where in the vicinity of a site where bored or driven piling works are to be carried out there are old structures which are likely to be damaged, tell-tales shall be fixed on such structures to watch their behaviour and timely precautions taken against any undesirable effect.

In case of bored pile measures shall be taken to ensure that there is no appreciable movement of soil mass into the borehole which may cause subsidence to any existing foundation in the close proximity. In wet holes where such possibilities are likely to be there the same shall be minimized by approved technique and the operation should be planned.

7.3.6.3 During construction, inspection shall be made by the engineer-in-charge to ensure that all protective works carried out to safe-guard the adjoining property are sufficient and in good order to ensure safety.

7.3.6.4 Before carrying out any excavation work/pile driving, the position, depth and size of underground structures, such as water pipes, mains, cables or other services in the vicinity to the proposed work, may be obtained from the Authority to prevent accidents to workmen engaged in excavation work and calamities for the general public. Prior to commencement of excavation detailed data of the type of soils that are likely to be met with during excavation shall be obtained and the type of protective works by way of shoring timbering, etc, shall be decided upon for the various strata that are likely to be encountered during excavation. For detailed information regarding safety requirements during excavation reference may be made to **Suffix [7(19)].**

7.3.7 GENERAL REQUIREMENTS AND COMMON HAZARDOUS DURING EXCAVATION

7.3.7.1 Location of Machinery and Tools

Excavating machinery consisting of both heavy and light types shall be kept back from the excavation site at a distance which would be safe for such type of equipment. Heavy equipment, such as excavating machinery and road traffic shall be kept back from the excavated sites at a distance of not less than the depth of trench or at least 6 m for trench deeper than 6 m. Care shall also be taken to keep excavating tools and materials far away from the edge of trench to prevent such items being inadvertently knocked into the trench.

7.3.7.2 Excavated Materials

Excavated materials shall be kept back from the edges of the trench to provide clear berm of safe width. Where this is not feasible, the protective works designed for the trenches shall take into consideration, the additional load due to overburden of materials.

7.3.7.2.1 Other Surcharges

Proximity of buildings, piles of lumber, crushed rocks, sand and other constructional materials, large trees, etc, may impose surcharges on the side of the trench to cause sliding, etc. Under these conditions additional protective works shall be provided to support the sides of the trench.

7.3.7.3 Types of Strata

Adequate precautions, depending upon the type of strata met with during excavation (like quick sand, loose fills and loose boulder) shall be taken to protect the workmen during excavation. Effect of climatic variations and moisture content variations on the materials under excavation shall be constantly watched and precautions taken, where necessary, immediately to prevent accidents at work site.

7.3.7.4 Overhang and Slopes

During any excavation, sufficient slopes to excavated sides by way of provision of steps or gradual slopes shall be provided to ensure the safety of men and machine working in the area.

7.3.7.5 Blasting

Blasting for foundation of building is prohibited unless special permission is obtained from the Authority. Where blasting technique has to be resorted to, prior inspection for the stability of slopes shall be carried out. After blasting, overhangs or loose boulders shall be cleared by expert workers carrying out blasting prior to continuation of the excavation by normal working parties.

7.3.7.5.1 Burrowing

Burrowing or mining or what is known as ‘gophering’ shall not be allowed. In any trench where such methods have been followed, the cavities felt shall be eliminated by cutting back the bare slope before removing any further material from the section of the trench.

7.3.7.6 Health Hazards

Where gases or fumes are likely to be present in trenches, gas detector must be used to find out which types of gases present in trenches and to measure the percent of Oxygen level and then sufficient mechanical ventilation, to protect the health and safety of persons working there, shall be provided during the working time. If necessary, the personnel working there shall be provided with respiratory protective equipment when work in such unhealthy conditions has to be carried out. The precautionary measures provided shall be inspected by the local health authorities prior to commencement of the work.

7.3.7.7 Safety of Materials

Materials required for excavation, like ropes, planks for gangways and walkways, ladders, etc, shall be inspected by the Competent Safety personnel and engineer-in-charge who shall ensure that no accident shall occur due to the failure of such materials (see Part 6 ‘Building Materials’).

7.3.7.8 Fencing and Warning Signals

Where excavation is going on, for the safety of public and the workmen, fencing shall be erected, if there is likelihood of the public including cattle frequenting the area. Sufficient number of notice boards and danger sign lights shall be provided in the area to avoid any member of public from inadvertently falling into the excavation. When excavations are being done on roads, diversion of the roads shall be provided with adequate notice board and lights indicating the diversion well ahead. Where necessary, recourse may be had for additional precautionary measures by way of watchmen to prevent accident to the general public, especially during hours of darkness.

7.3.7.9 Effect of Freezing and Thawing

Due to expansion of water when freezing, rock fragments, boulders, etc, are frequently loosened. Therefore, the side walls of the excavation shall be constantly watched for signs of cracks during a thaw. When depending in whole or in part on freezing to support the side walls, great care shall be taken during thaws to provide suitable bracing or remedy the condition by scaling of the loose material from the sides.

7.3.7.10 Vibrations from Nearby Sources

Vibration due to adjacent machinery, vehicles, railroads, blasting, piling and other sources require additional precautions to be taken.

7.3.7.11 Precautions While Using Petroleum Powered Equipment

At the site of excavation, where petroleum powered equipment is used, petroleum vapours are likely to accumulate at lower levels and may cause depleting of Oxygen and fire explosion under favorable circumstances. Therefore, Gas detector must be used to measure the percentage of Oxygen level, especially in such as Trenches and confined spaces where job need to be carried out.Care should, therefore, be taken to avoid all sources of ignition in such places.

7.3.8 PILING AND OTHER DEEP FOUNDATIONS

7.3.8.1 General

7.3.8.1.1 Safety Programme

All operations shall be carried out under the immediate charge of a properly qualified and competent foreman who shall also be responsible for the safety arrangements of the work.

7.3.8.1.2 For work during night, lighting of at least 100 lux intensity shall be provided at the work site.

7.3.8.1.3 Barricading/fencing shall be provided, wherever necessary, around the working area or the watchmen provided to prevent onlookers from trespassing into the construction sites. In case of digging a bore hole, precautions shall be taken that it is properly barricaded and is not left open to avoid accidental fall into the bore well.

7.3.8.1.4 The working area shall be investigated to ascertain the presence of any buried obstruction and actual position of all service lines passing through the work site shall be known before the work commences. Particular attention shall be given in case live electrical cables pass underground, which may interfere within the depth of the foundation.

7.3.8.1.5 The safety provisions shall be brought to the notice of all concerned and matters needing special attention shall be displayed at a prominent place at the work spot.

7.3.8.1.6 All necessary personal protective equipment like full body harnesses, safety helmets and safety shoes, as considered suitable, shall be kept available for the use of persons employed on the site and maintained in condition suitable for immediate use.

7.3.8.1.7 A first-aid kit shall be maintained at the site near the place of work, to comply with the requirements and provisions for the work.

7.3.8.1.8 Those engaged in mixing and stacking of cement bags or any other material injurious to human body shall be provided with protective wear suitable for the purpose. Welders engaged in the work of welding shall use welding goggles/shields, helmets and gloves.

7.3.8.1.9 Every crane driver or hoisting appliance operator shall be competent to the satisfaction of the Site Safety Manager and no person under the age of 21 years should be in-charge of any hoisting machine including any scaffolding winch, or give signals to operator.
Crane driver and hoisting appliance operator shall posses the knowledge of inherent risks involved in the operation of lifting appliances by undergoing a formal training at any institution

of national importance acceptable to the employer and is medically examined periodically including in compliance to the requirements as may be specified in the HPBC Guidelines.

7.3.8.1.10 Working in compressed air, in case of deep foundations, requires several precautions to be observed to safeguard the workmen against severe hazards to life, compressed air disease and related ailments. For detailed information regarding safety requirements, reference may be made to **Suffix [7(25)].**

7.3.8.2 Piling Rig

a) There are numerous types of piling rigs in piling work, depending on the need for the site conditions. While utilizing specialized rigs the instructions issued by the suppliers shall be kept in view. Pile drivers shall not be erected in dangerous proximity to electric conductors. If two pile drivers are erected at one place these shall be separated by a distance at least equal to the longest leg in either rig.

b) The frame of any rig shall be structurally safe for all anticipated dead, live or wind loads. Whenever there is any doubt about the structural strength, suitable test shall be carried out by the foreman and the results of the test recorded. No pile driving equipment shall be taken into use until it has been inspected and found to be safe.

c) Pile drivers shall be firmly supported on heavy timber sills,concrete beds or other secure foundation. If necessary, to prevent danger, pile drivers shall be adequately guyed. When the rig is not in use, extra precautionary measures for stability, such as securing them with minimum four guys, shall be adopted to prevent any accidents due to wind, storm, gales and earthquake. The counter concrete weight on the Piling Rig shall be adequately guyed with the steel ropes to prevent accidently dropping while piling driving operation.

d) Access to working platforms and the top pulley shall be provided by ladders. Working platforms shall be protected against the weather.

e) In tall driven piling rigs or rigs of similar nature where a ladder is necessary for regular use, the ladder shall be securely fastened and extended for the full height of the rig. The ladder shall also be matained in good condition at all times.

f) Exposed gears, fly wheels, etc, shall be fully enclosed. Boilers, hoisting drums and brakes shall be kept in good condition and sheltered from weather, wherever possible.

g) Pile driving equipment in use shall be inspected by a competent engineer at regular intervals not exceeding three months. A register shall be maintained at the site of work for recording the results of such inspected pile lines and pulley blocks shall be inspected by the foreman before the beginning of each shift, for any excess wear or any other defect.

h) Defective parts of pile drivers, such as sheaves, mechanism slings and hose shall be repaired by only competent person and duly inspected by foreman-in-charge of the rig and the results recorded in the register. No steam or air equipment shall be repaired while it is in operation or under pressure. Hoisting ropes on pile drivers shall be made of galvanized steel.
All bolts and nuts which are likely to be loosened due to vibration during pile driving shall be checked regularly and tightened.

i) Steam and air lines shall be controlled by easily accessible shut-off valves.These lines shall consist of armoured hose or its equivalent. The hose of steam and air hammers shall be securely lashed to the hammer so as to prevent it from whipping if a connection breaks. Couplings of sections of hose shall be additionally secured by ropes or chains.

j) When not in use the hammer shall be in dropped position and shall beheld in place by a cleat, timber or any other suitable means.

k) For every hoisting machine and for every chain rig hook, shackle, swivel and pulley block used in hoisting or as means of suspension, the safe working loads shall be ascertained. In case of doubt, actual testing shall be carried out and the working load shall be taken as half of the tested load. Every hoisting machine and all gears referred to above shall be plainly marked with the safe working load. In case of a hoisting machine having a variable safe working load, each safe working load together with the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear shall be loaded beyond the safe working load except for the purpose of testing.

All hoisting appliances should be fitted with automatic safe load indicator, boom angle indicator, swing alarm, back horn, over lift boom alarm. A register shall be maintained containing a system of identification of all tools and tackles, safe working load and date of examination by competent person. All loads shall have tag-lines attached in order to ensure that the load can be controlled at all times.

l) Motor gearing, transmission, electrical wiring and other dangerous parts of hoisting appliances should be provided with efficient safeguards. Hoisting appliances shall be provided with such means as will reduce, to the minimum, the risk of accidental descent of the load and adequate precautions shall be taken to reduce to the minimum, the risk of any part of suspended load becoming accidentally displaced. When workers are employed on electrical installations which are already energized, insulating mats and wearing apparel, such as gloves, etc, as may be necessary, shall be provided. Sheaves on pile drivers shall be guarded so that workers may not be drawn into them.

When loads have to be inclined:

a) They shall be adequately counter-balanced, and
b) The tilting device shall be secured against slipping.
c) Adequate precautions shall be taken to prevent a pile driver from overturning if a wheel breaks.
d) Adequate precautions shall be taken by providing stirrups or by other effective means, to prevent the rope from coming out of the top pulley or wheel.
e) Adequate precautions shall be taken to prevent the hammer from missing the pile.
f) If necessary, to prevent danger, long piles and heavy sheet piling should be secured against falling.
g) Wherever steam boilers are used, the safety regulations of boilers shall be strictly followed and safety valves shall be adjusted to 0.07 N/mm2 in excess of working pressure accurately.
h) Where electricity is used as power for piling rig, only armoured cable conforming to the relevant EI Standard shall be used and the cable shall be thoroughly waterproofed.
i) All checks as given in any manuals issued by the manufacturers shall be carried out.

7.3.8.3 Operation of Equipment

a) Workers employed in the vicinity of pile drivers shall wear helmets conforming to the **Suffix [7(26)].**
b) Piles shall be prepared at a distance at least equal to twice the length of the longest pile from the pile driver.
c) Piles being hoisted in the rig should be so slung that they do not have to be swung round, and may not inadvertently, swing or whip round. A hand rope shall be fastened to a pile that is being hoisted to control its movement. While a pile is being guided into position in the leads, workers shall not put their hands or arms between the pile and the inside guide or on top of the pile, but shall use a rope for guiding.
d) While a pile is being hoisted all workers not actually engaged in the operation shall keep at a distance which ensures safety. Piles shall not be slewed over public areas without stopping the pedestrians and road traffic first.

e) Before a wood pile is hoisted into position it shall be provided with an iron ring or cap over the driving end to prevent brooming. When creosoted wood piles are being driven, adequate precautions shall be taken, such as the provision of personal protective equipment and barrier creams, to prevent workers receiving eye or skin injuries from splashes of creosote.
f) When piles are driven at an inclination to the vertical, if necessary, to prevent danger, these should rest in a guide.
g) No steam or air shall be blown down until all workers are at a safe distance.

7.3.8.4 Sheet Piling

7.3.8.4.1 If necessary to prevent danger from wind or other sources, a hand rope shall be used to control the movement of steel sheet sections that are being transported.

7.3.8.4.2 Workers who have to sit on a steel sheet section to interlock sheets shall be provided with stirrups or other devices to afford them a safe seat. Workers shall not stand or sit on sheet piling while it is being released from the slings, lowered or moved into position.

7.3.8.4.3 Workers handling sheets should wear gloves.

7.3.8.4.4 If necessary to prevent danger from displacement by the current, steel sheet sections shall be braced until they are firmly in position. If necessary to prevent danger from undercutting of the cofferdam by the current a substantial berm shall be installed upstream.

7.3.8.4.5 Adequate pumping facilities shall be available at cofferdams to keep them clear of water. Also adequate means of escape, such as ladders and boats shall be provided at cofferdams for the protection of workers in case of flooding.

7.3.8.4.6 Adequate supplies of life-saving equipment shall be provided for workers employed on cofferdams.

7.3.8.4.7 When sheet sections are being removed, their movements shall be controlled by cables or other effective means.

7.3.9 WALLS

7.3.9.1 General

Depending on the type of wall to be constructed the height of construction per day shall be restricted to ensure that the newly constructed wall does not come down due to lack of strength in the lower layers. Similarly, in long walls adequate expansion/crumple joints shall be provided to ensure safety.

7.3.9.2 Scaffold

Properly designed and constructed scaffolding built by competent workmen shall be provided during the construction of the walls to ensure the safety of workers. The scaffolding may be of timber, metal or bamboo sections and the materials in scaffolding shall be inspected for soundness, strength, etc, at site by the engineer-in-charge prior to erection of scaffolds. Steel scaffolds intended for use in normal building construction work shall conform to **Suffix [7(27)].** Bamboo and timber scaffolds shall be properly tied to the junctions with coir ropes of sufficient strength or mechanical joints to ensure that joints do not give way due to the load of workmen and material. Joining the members of scaffolds only with nails shall be prohibited as they are likely to get loose under normal weathering conditions. In the erection or maintenance of tall buildings, scaffoldings shall be of noncombustible material especially when the work is being done on any building in occupation. After initial construction of the scaffolding, frequent

inspections of scaffolding shall be carried out regularly. The platforms, gangways and runways provided on the scaffoldings shall be of sufficient strength and width to ensure safe passage for the workers working on the scaffolding. The joints provided in these gangways, platforms, etc, shall be such as to ensure a firm foot-hold to the workmen.Where necessary, cross bars shall be provided to the full width of gangway or runway to facilitate safe walking. For detailed information regarding safety requirements for erection, use and dismantling of scaffolds, reference may be made to **Suffix [7(28)].**

7.3.9.2.1 The engineer-in-charge shall ensure by frequent inspections that gangways of scaffolding have not become slippery due to spillage of material. Loose materials shall not be allowed to remain on the gangways. Where necessary, because of height or restricted width, hand-rails shall be provided on both sides. Workers shall not be allowed to work on the scaffolding during bad weather and high winds.

7.3.9.2.2 In the operations involved in the erection or maintenance of outside walls, fittings, etc, of tall buildings, it is desirable to use one or more net(s) for the safety of the workmen when the workers are required to work on scaffoldings.

7.3.9.3 Ladders

All ladders shall be constructed of sound materials and shall be capable of carrying their intended loads safely. The ladders shall have not only adequate strength but rigidity as well. If a ladder shows tendency to spring, a brace shall be attached to its middle and supported from some other non-yielding fixed object. No ladder having a missing or defective rung or one which depends for its support solely on nails, shall be used, Ladders shall not be used as guys, braces or skids or for any other purpose for which they are not intended. They shall not be used in horizontal position as runways. They shall not be overcrowded. Wherever possible, ladders shall not be spliced. Where splicing is unavoidable, it shall be done only under the supervision of engineer-in-charge. Ladders leading to landings or walkways shall extend at least 1 m above the landing and shall be secured at the upper end. To prevent slipping, a ladder shall be secured at the bottom end. If this cannot be done, a person shall be stationed at the base whenever it is in use.

As a further precaution, the pitch at which a lean-to-ladder is used shall be such that the horizontal distance of its foot from the vertical plane of its top shall be not more than one quarter of its length. If the surface of the floor on which the ladder rests is smooth or sloping, the ladder shall be provided with non-slip bases. If the use of a ladder is essential during strong winds, it shall be securely lashed in position. No ladder shall be placed or leant against window pane, sashes or such other unsafe or yielding objects, nor placed in front of doors opening towards it. If setup in driveways, passageways or public walkways, it shall be protected by suitable barricades. When ascending or descending, the user shall face the ladder, use both his hands and place his feet near the ends of the rungs rather than near the middle. It is dangerous to lean more than 30 cm to side in order to reach a larger area from a single setting of the ladder. Instead, the user shall get down and shift the ladder to the required position.

Metal ladders shall not be used around electrical equipment or circuits of any kind where there is a possibility of coming in contact with the current. Metal ladders shall be marked with signs reading **'CAUTION: DO NOT USE NEAR ELECTRICAL EQUIPMENT'**.

Wooden ladders shall be inspected at least once in a month for damage and deterioration. Close visual inspection is recommended in preference to load testing. This condition is particularly applicable to rope and bamboo ladders wherein fraying of ropes and damage to bamboo is likely to occur due to materials falling on them. When a ladder has been accidentally dropped it shall be inspected by the engineer-in-charge prior to re-use. Overhead protection shall be provided for workmen under ladder. For detailed information regarding safety requirements for use of ladders, reference may be made to **Suffix [7(29)].**

7.3.9.4 Opening in Walls

Whenever making of an opening in the existing wall is contemplated, adequate supports against the collapse or cracking of the wall portion above or roof or adjoining walls shall be provided.

7.3.9.4.1 Guarding of Wall Openings and Holes

Wall opening barriers and screens shall be of such construction and mounting that they are capable of withstanding the intended loads safely. **For detailed information may be made to Suffix [7(30)].** Every wall opening from which there is a drop of more than 1.2 m shall be guarded by one of the following:

(a) Rail, roller, picket fence, half door or equivalent barrier - The guard may be removable but should preferably be hinged or otherwise mounted so as to be conveniently replaceable. Where there is danger to persons working or passing below on account of the falling materials, a removable toe board or the equivalent shall also be provided. When the opening is not in use for handling materials, the guards shall be kept in position regardless of a door on the opening. In addition, a grab handle shall be provided on each side of the opening. The opening should have a sill that projects above the floor level at least 25 mm.

(b) Extension platform into which materials may be hoisted for handling, shall be of full length of the opening and shall have side rails or equivalent guards.

7.3.9.4.2 Every chute wall opening from which there is a drop of more than 1.2 m shall be guarded by one or more of the barriers specified in 7.3.9.4.1 or as required by the conditions.

7.3.9.5 Projection from Walls

Whenever projections cantilever out of the walls, temporary formwork shall be provided for such projections and the same shall not be removed till walls over the projecting slabs providing stability load against overturning are completely constructed.

7.3.10 COMMON HAZARDS DURING WALLING

7.3.10.1 Lifting of Materials for Construction

Implements used for carrying materials to the top of scaffoldings shall be of adequate strength and shall not be overloaded during the work. Where workers have to work below scaffoldings or ladder, overhead protection against the falling materials shall be provided. Care shall be taken in carrying large bars, rods, etc, during construction of the walls to prevent any damage to property or injury to workers.

7.3.10.2 Haulage of Materials

a) In case of precast columns, steel beams, etc, proper precautions shall be taken to correctly handle, use and position them with temporary arrangement of guys till grouting of the base.

b) Manila or sisal rope shall not be used in rainy season for hoisting of heavy materials as they lose their strength with alternate wetting and drying.

7.3.10.3 Electrical Hazards

No scaffolding, ladder, working platform, gangway runs, etc, shall exist within 3.0 m from any uninsulated electric wire.

7.3.10.4 Fire Hazards

Gangways and the ground below the scaffolding shall be kept free from readily combustible materials including waste and dry vegetation at all times.

7.3.10.4.1 Where extensive use of blow torch or other flame is anticipated scaffoldings, gangways, etc, shall be constructed with fire resistant materials. A portable dry powder extinguisher of 4.0 kg capacity shall be kept handy.

7.3.10.5 Mechanical Hazards

Care shall be taken to see that no part of scaffolding or walls is struck by truck or heavy moving equipment and no materials shall be dumped against them to prevent any damage. When such scaffoldings are in or near a public thoroughfare, sufficient warning lights and boards shall be provided on the scaffoldings to make them clearly visible to the public.

7.3.10.6 Fragile Materials

During glazing operations, adequate precautions shall be taken to ensure that the fragments of fragile materials do not cause any injury to workers or general public in that area by way of providing covering to such material, side protection at work site, etc.

7.3.11 ROOFING

7.3.11.1 Prevention of accidental falling of workmen during the construction of roofs shall be ensured by providing platforms, catch ropes, etc. If the materials are to be hoisted from the ground level to the roof level, adequate precautions shall be taken by way of correct technique of handling, hoists of sufficient strength to cater for the quantity of stores to be hoisted and prevention of overloading such hoists or buckets, prevention of overturning of hoists or buckets. Where in a multi-storeyed building, the floor of one storey is to be used for storage of materials for the construction of roofs, it shall be ensured that the quantum of stores kept on the floor along with the load due to personnel engaged in the construction work shall not exceed the rated capacity of the floors.

7.3.11.2 While roofing work is being done with corrugated galvanized iron or asbestos cement sheets, it shall be ensured that joints are kept secured in position and do not slip, thus causing injury to workers. Workers should not be allowed to walk on asbestos cement sheets but should be provided with walking boards. While working with tiles, it shall be ensured that they are not kept loose on the roof site resulting in falling of tiles on workers in lower area. In slopes of more than 30° to the horizontal, the workers shall use ladders or other safety devices to work on the roof.

7.3.11.3 If any glass work is to be carried out in the roof, it shall be ensured that injury to passerby due to breaking of glass is prevented. During wet conditions, the workers shall be allowed to proceed to work on a sloping roof, only if the engineer-in-charge has satisfied himself that the workers are not likely to slip due to wet conditions.

7.3.11.4 ***Flat Roof —*** In any type of flat roof construction, any formwork provided shall be properly designed and executed to ensure that it does not collapse during construction. During actual construction of roof, frequent inspection of the formwork shall be carried out to ensure that no damage has occurred to it.

7.3.11.5 While using reinforcement in roofs, it shall be ensured that enough walking platforms are provided in the reinforcement area to ensure safe walking to the concreting area. Loose wires and unprotected rod ends shall be avoided.

7.3.11.6 Guarding of Floor Openings and Floor Holes

a) Every temporary floor opening shall have railings, or shall be constantly attended by someone. Every floor hole into which persons can, accidentally fall shall be guarded by either

1) A railing with toe board on all exposed sides, or
2) A floor hole cover the adequate strength and it should be hinged in place. When the cover is not in place, the floor hole shall be constantly attended by someone or shall be protected by a removable railing.

b) Every stairway floor opening shall be guarded by a railing on all exposed sides, except at entrance to stairway. Every ladder way floor opening or platform shall be guarded by a guard railing with toe board on all exposed sides (except at entrance to opening), with the passage through the railing either provided with a swinging gate or so offset that a person can not walk directly into the opening.

c) Every open-sided floor or platform 1200mm or more above adjacent floor or ground level shall be guarded by a railing (or the equivalent) or all open sides, except where there is entrance to ramp, stair-way, or fixed ladder. The railing shall be provided with a toe board beneath the open sides wherever

1) Persons may pass;
2) There is moving machinery; or
3) There is equipment with which falling materials could create a hazard.

For detailed information, reference may be made to **Suffix [7(30)].**

7.3.11.7 Fire Safety Requirements for protected shafts and openings

The provision of Protected shafts and openings shall be in compliance with the protection of openings permitted in elements of structure or other forms of fire resisting construction required to act as a barrier to fire and smoke. All protected shafts containing services shall be casted back all gaps after installation of services or sealed back the gaps with fire stop material as per fire rating requirements of floor or wall as defined in MFSC-2020.

7.3.12 ADDITIONAL SAFETY REQUIREMENTS FOR ERECTION OF CONCRETE FRAMED STRUCTURES (HIGH-RISE BUILDINGS)

7.3.12.1 Handling of Plant

7.3.12.1.1 Mixers

a) All gears, chains and rollers of mixers shall be properly guarded. If the mixer has a charging skip the operator shall ensure that the workers are out of danger before the skip is lowered. Railings shall be provided on the ground to prevent anyone walking under the skip while it is being lowered.

b) All cables, clamps, hooks, wire ropes, gears and clutches, etc, of the mixer, shall be checked and cleaned, oiled and greased, and serviced once a week. A trial run of the mixer shall be made and defects shall be removed before operating a mixer.

c) When workers are cleaning the inside of the drums, and operating power of the mixer shall be locked in the off position and all fuses shall be removed and a suitable notice hung at the place.

7.3.12.1.2 Cranes

a) Crane rails where used shall be installed on firm ground and shall be properly secured. In case of tower cranes, it shall be ensured that the level difference between the two rails remains within the limits prescribed by the manufacturer to safeguard against toppling of the crane. Requirements for tower cranes as given in 7.3 shall also be complied with.

b) Electrical wiring which can possibly touch the crane or any member being lifted shall be removed, or made dead by removing the controlling fuses and in their absence controlling switches.

c) All practical steps shall be taken to prevent the cranes being operated in dangerous proximity to a live overhead power line. In particular, no member of the crane shall be permitted to approach within the minimum safety distances as laid down in 7.2.10.23. If it becomes necessary to operate the cranes with clearances less than those specified above, it shall be ensured that the overhead power lines shall invariably be shut off during the period of operation of cranes. Location of any underground power cables in the area of operation shall also be ascertained and necessary safety precautions shall be taken.

d) Cranes shall not be used at a speed which causes the boom to swing.

e) A crane shall be thoroughly examined at least once in a period of 6 months by a competent person who shall record a certificate of the check.

f) The operator of the crane shall follow the safe reach of the crane as shown by the manufacturer.

g) No person shall be lifted or transported by the crane on its hook or boom.

h) Toe boards and limit stops should be provided for wheel barrows on the loading/unloading platforms. Material should be loaded securely with no projections.

i) Concrete buckets handled by crane or overhead cableway shall be suspended from deep throated hooks, preferably equipped with swivel and safety latch. In the concrete buckets, both bottom drop type and side drop type, closing and locking of the exit door of the bucket shall always be checked by the man-in-charge of loading concrete in the bucket to avoid accidental opening of the exit door and consequent falling of concrete.

j) Interlocking or other safety devices should be installed at all stopping points of the hoists. The hoists shaft way should be fenced properly.

k) When the buck or other members being lifted are out of sight of the crane operator, a signalman shall be posted in clear view of the receiving area and the crane operator.

l) A standard code of hand signals shall be adopted in controlling the movements of the crane, and both the driver and the signaler shall be thoroughly familiar with the signals. The driver of the crane shall respond to signals only from the appointed signaler but shall obey stop signal at any time no matter who gives it.

m) If a traveling gantry crane is operating over casting beds, a warning signal which sounds automatically during travel should be provided to avoid accidents to workmen crossing or standing in the path of the moving loads.

For detailed information (tower crane), reference may be made to Suffix [7(48)].

7.3.12.1.3 Trucks

When trucks are being used on the site, traffic problems shall be taken care of. A reasonably smooth traffic surface shall be provided. If practicable, a loop road shall be provided to permit continuous operation of vehicles and to eliminate their backing. If a continuous loop is not possible, a turnout shall be provided. Backing operations shall be controlled by a signalman positioned so as to have a clear view of the area behind the truck and to be clearly visible to the truck driver. Movement of workmen and plant shall be routed to avoid crossing, as much as possible, the truck lanes.

7.3.12.2 Formwork

a) Formwork shall be designed after taking into consideration spans, setting temperature of concrete, dead load and working load to be supported and safety factor for the materials used for formwork.

b) All timber formwork shall be carefully inspected before use and members having cracks and excessive knots shall be discarded.

c) As timber centering usually takes an initial set when vertical load is applied, the design of this centering shall make allowance for this factor.

d) The vertical supports shall be adequately braced or otherwise secured in position that these do not fall when the load gets released or the supports are accidently hit.

e) Tubular steel centering shall be used in accordance with the manufacturer’s instructions. When tubular steel and timber centering is to be used in combination necessary precautions shall be taken to avoid any unequal settlement under load.

f) A thorough inspection of tubular steel centering is necessary before its erection and members showing evidence of excessive resting, kinks, dents or damaged welds shall be discarded. Buckled or broken members shall be replaced. Care shall also be taken that locking devices are in good working order and that coupling pins are effectively aligned to frames.

g) After assembling the basic unit, adjustment screws shall be set to their approximate final adjustment and the unit shall be level and plumb so that when additional frames are installed the tower shall be in level and plumb. The centering frames shall be tied together with sufficient braces to make a rigid and solid unit. It shall be ensured that struts and diagonals braces are in proper position and are secured so that frames develop full load carrying capacity. As erection progresses, all connecting devices shall be in place and shall be fastened for full stability of joints and units.

h) In case of timber posts, vertical joints shall be properly designed. The connections shall normally be with bolts and nuts. Use of rusted or spoiled threaded bolts and nuts shall be avoided.

i) Unless the timber centering is supported by a manufacturer's certificate about the loads it can stand, centering shall be designed by a competent engineer.

j) Centering layout shall be made by a qualified engineer and shall be strictly followed. The bearing capacity of the soil shall be kept in view for every centering job. The effect of weather conditions as dry clay may become very plastic after a rainfall and show marked decrease in its bearing capacity.

k) Sills under the supports shall be set on fm soil or other suitable material in a pattern which assures adequate stability for all props. Care shall be taken not to disturb the soil under the supports. Adequate drainage shall be provided to drain away water coming due to rains, washing of forms or during the curing of the concrete to avoid softening of the supporting soil starta.

l) All centering shall be finally, inspected to ensure that:
   1) Footings or sills under every post of the centering are sound
   2) All lower adjustment screws or wedges are sung against the legs of the panels
   3) All upper adjustment screws or heads of jacks are in full contact with the formwork.
   4) Panels are plumb in both directions.
   5) All cross braces are in place and locking devices are in closed and secure position.
   6) In case of balconies, the props shall be adequate to transfer the load to the supporting point.

m) During pouring of the concrete, the centering shall be constantly inspected and strengthened, if required, wedges below the vertical supports tightened and adjustment screws properly adjusted as necessary. Adequate protection of centering shall be secured from moving vehicles or swinging loads.

n) Forms shall not be removed earlier than as laid down in the specifications and until it is certain that the concrete has developed sufficient strength to support itself and all loads that will be imposed on it. Only workmen actually engaged in removing the formwork shall be allowed in the area during these operations. Those engaged in removing the formwork shall wear helmets, gloves and heavy soled shoes and approved safety belts if adequate footing is not provided above 2 m level. While cutting any tying wires in tension, care shall be taken to prevent backlash which might hit a workman.
   The particular order in which the supports are to be dismantled should befollowed according to the instructions of the site engineer.

7.3.12.3 Ramps and Gangways

a) Ramps and gangways shall be of adequate strength and evenly supported. They shall either have a sufficiently flat slope or shall have cleats fixed to the surface to prevent slipping of workmen. Ramps and gangways shall be kept free from grease, mud, snow or other slipping hazards or other obstructions leading to tripping and accidental fall of a workman.

b) Ramps and gangways meant for transporting materials shall have even surface and be of sufficient width and provided with skirt boards on open sides.

7.3.12.4 Materials Hoists

a) The hoist should be erected on a firm base, adequately supported and secured. All materials supporting the hoist shall be appropriately designed and strong enough for the work intended and free from defects.

b) The size of the drum shall match the size of the rope. Not less than two full turns of rope shall remain on the drum at all times. Ropes shall be securely attached to the drum.

c) All ropes, chains and other lifting gear shall be properly made of sound materials, free from defects and strong enough for the work intended. They shall be examined by a competent person who shall clearly certify the safe working load on each item and the system.

d) Hoist ways shall be protected by a substantial enclosure at ground level, at all access points and wherever persons may be struck by any moving part.

e) Gates at access points should be at least 2 m high wherever possible. Gates shall be kept closed at all times except when required open for immediate movement of materials at that landing place.

f) All gates shall be fitted with electronic or mechanical interlocks to prevent movement of the hoist in the event of a gate being opened.

g) Winches used for hoists shall be so constructed that a brake is applied when the control lever or switch is not held in the operating position (dead-man's handle).

h) The hoist tower shall be tied to a building or structure at every floor level or at least every 3 m. The height of the tower shall not exceed 6 m after the last tie or a lesser height as recommended by the manufacturer. All ties on a hoist tower shall be secured using right angled couples.

i) The hoist shall be capable of being operated only from one position at a time. It shall not be operated from the cage. The operator shall have a clear view of all levels or, if he has not, a clear and distinct system of signaling shall employed.

j) All hoist platform shall be fitted with guards and gates to a height of at least 1 m, to prevent materials rolling/falling from the platform.

k) Where materials extend over the height of the platform guards, a frame shall be fitted and the materials secured to it during hoisting/lowering. (Care should be taken to ensure that neither the frame nor materials interfere or touch any part of the hoisting mechanism.)

l) The platform of a goods hoist shall carry a notice stating:
   1) the safe working load; and
   2) that passengers shall not ride on the hoist.

m) All hoist operators shall be adequately trained and competent, and shall be responsible for ensuring that the hoist is not overloaded or otherwise misued.

n) All hoists shall be tested and thoroughly examined by a competent person before use on a site, after substantial alteration, modification or repair of hoists, and at least every 6 months.

o) Every hoist shall be inspected at least once each week by a competent person and a record of these inspections kept.

7.3.12.5 Prestressed Concrete

a) In pre-stressing operations, operating, maintenance and replacement instructions of the supplier of the equipment shall be strictly adhered to.

b) Extreme caution shall be exercised in all operations involving the use of stressing equipment as wires/strands under high tensile stresses become a lethal weapon.

c) During the jacking operation of any tensioning element(s) the anchor shall be kept turned up close to anchor plate, wherever possible, to avoid serious damage if a hydraulic line fails.

d) Pulling-headers, bolts and hydraulic jacks/rams shall be inspected for signs of deformation and failure. Threads on bolts and nuts should be frequently inspected for diminishing cross section. Choked units shall be carefully cleaned.

e) Care shall be taken that no one stands in line with the tensioning elements and jacking equipment during the tensioning operations and that no one is directly over the jacking equipment when deflection is being done. Signs and barriers shall be provided to prevent workmen from working behind the jacks when the stressing operation is in progress.

f) Necessary shields should be put up immediately behind the prestressing jacks during stressing operations.

g) Wedges and other temporary anchoring devices shall be inspected before use.

h) The prestressing jacks shall be periodically examined for wear and tear.

7.3.12.6 Erection of Prefabricated Members

a) A spreader beam shall be used wherever possible so that the cable can be as perpendicular to the members being lifted as practical. The angle between the cable and the members to be lifted shall not be less than 60°.

b) The lifting wires shall be tested for double the load to be handled at least once in six months. The guy line shall be of adequate strength to perform its function of controlling the movement of members being lifted.

c) Temporary scaffolding of adequate strength shall be used to support precast members at predetermined supporting points while lifting and placing them in position and connecting them to other members.

d) After erection of the member, it shall be guyed and braced to prevent it from being tipped or dislodged by accidental impact when setting the next member.

e) Precast concrete units shall be handled at specific picking points and with specific devices. Girders and beams shall be braced during transportation and handled. In such a way as to keep the members upright.

f) Methods of assembly and erection specified by the designer, shall be strictly adhered to at site. Immediately on erecting any unit in position, temporary connections or supports as specified shall be provided before releasing the lifting equipment. The permanent structural connections shall be established at the earliest opportunity.

7.3.12.7 Structural Connections

a) When reliance is placed on bond between precast and in-situ concrete the contact surface of the precast units shall be suitably prepared in accordance with the specifications.

b) The packing of joints shall be carried out in accordance with the assembly instructions.

c) Leveling devices, such as wedges and nuts which have no load bearing function in the completed structure shall be released or removed as necessary prior to integrating the joints.

d) If it becomes necessary to use electric power for in-situ work, the same should be stepped down to a safe level as far as possible.

7.3.12.8 Workers working in any position where there is a falling hazard shall wear safety belts or other adequate protection shall be provided.

7.3.13 ADDITIONAL SAFETY REQUIREMENTS FOR ERECTION OF STRUCTURAL STEEL WORK

7.3.13.1 Safety Organization

The agency responsible for erecting the steel work should analyze the proposed erection scheme for safety; the erection scheme should cover safety aspects right from the planning stage up to the actual execution of the work.

7.3.13.2 Safety of Work persons

a) While engaging persons for the job the supervisor should check up and make sure that they are skilled in the particular job they have to perform.
   1) The personnel protective equipment (helmets, goggles etc.,) shall be worn properly and at all times during the work and shall conform to the **Suffix [7(26)].**
   2) The safety goggles shall be used while performing duties which are hazardous to eye like drilling, cutting and welding. The goggles used shall conform to the **Suffix [7(32)]** and should suit individual workers.
   3) The welders and gas cutters shall be equipped with proper protective equipment like gloves, safety boots, aprons and hand shields .The filter glass of the hand shield shall conform to **Suffix [7(31)]** and should be suitable to the eyes of the particular worker.
   4) When the work is in progress, the area shall be cordoned off by barricades to prevent persons from hitting against structural components, or falling into excavated trenches or getting injured by falling objects.
   5) Warning signs shall be displayed where necessary to indicate hazards, for example (a) '**440 VOLTS'**, (b) '**DO NOT SMOKE'**, (c) '**MEN WORKING AHEAD'**, etc. Hand lamps shall be of low voltage preferably 24 V to prevent electrical hazards.
   6) All electrically operated hand tools shall be provided with double earthing.

b) Anchors for guys or ties shall be checked for proper placement. The weight of concrete in which the anchors are embedded shall be checked for uplift and sliding.

Split-end eye anchors shall only be used in good, solid rock.

The first load lifted by a guy derrick shall be kept at a small height for about 10 min and the anchors immediately inspected for any signs or indications of failure.

c) When a number of trusses or deep girders is loaded in one car or on one truck, all but one being lifted shall be tied back unless they have been tied or braced to prevent their falling over and endangering men unloading.

d) The erection gang shall have adequate supply of bolts, washers, rivets, pins, etc, of the correct size. Enough number of bolts shall be used in connecting each piece using a minimum of two bolts in a pattern to ensure that the joint will not fail due to dead load and erection loads. All splice connections in columns, crane girders, etc, shall be completely bolted or riveted or welded as specified in the drawing before erection.

e) Girders and other heavy complicated structural members may require special erection devices like cleats and hooks, which can be shop assembled and bolted or riveted or welded to the piece and may be left permanently in the place after the work.

f) If a piece is laterally unstable when picked at its centre, use of a balance beam is advisable, unless a pair of bridles slings can be placed far enough apart for them to act as safe lifting points. The top flange of a truss, girder or long beam may be temporarily reinforced with a structural member laid flat on top of the member and secured temporarily.

g) On deep girders, and even on some trusses, a safety 'bar' running their full length will aid the riggers, fitters and others employed on the bottom flange or bottom chord to work with greater safety. This can be a single 16 mm diameter wire rope through vertical stiffeners of such members about 1 m above the bottom flange and clamped at the ends with wire rope clamps. If the holes cannot be provided, short eye bolts can be welded to the webs of the girder at intervals to be removed and the surface chipped or ground to leave it smooth after all work on the piece has been completed.

h) Safety belts shall always be available at work spot to be used whenever necessary. The rope shall be chemically treated to resist dew and rotting. These shall not be tied on sharp edges of steel structures. They shall be tied generally not more than 2 m to 3 m away from the belt.

i) On a guy derrick or climbing crane job, the tool boxes used by the erection staff shall be moved to the new working floor each time the rig is changed. On a mobile crane job, the boxes shall be moved as soon as the crane starts operating in a new area too far away for the men to reach the boxes conveniently. While working a tall and heavy guy derrick, it is advisable to control tension in guys by hand winches to avoid jerks, which may cause an accident.

j) The proper size, number and spacing of wire rope clamps shall be used, depending on the diameter of the wire rope. They shall be properly fixed in accordance with **Suffix [7(33)]**. They shall be checked as soon as the rope has been stretched, as the rope, especially if new, tends to stretch under the applied load, which in turn may cause it to shrink slightly in diameter. The clamps shall then be promptly tightened to take care of this new condition. In addition, the clamps shall be inspected frequently to be sure that they have not slipped and he tight enough.

k) When the men can work safely from the steel structure itself, this preferable to hanging platforms or scaffolds, as it eliminates additional operations, which in turn, reduces the hazard of an accident.

l) To aid men working on floats or scaffolds, as well as men in erection gangs, or other gangs using small material, such as bolts and drift pins, adequate bolt baskets or similar containers with handles of sufficient strength and attachment to carry the loaded containers, shall be provided.

m) The men should be trained to use such containers, and to keep small tools gathered up and put away in tool boxes when not in use. Material shall not be dumped overboard when a scaffold is to be moved. Rivet heaters shall have safe containers or buckets for hot rivets left over at the end of the clay.

n) During the erection of tall buildings, it is desirable to use nylon nets of sufficient width at a height of 3 m to 4 m to provide safety to men, The safety net should be made from man or machine-made fiber ropes which are UV stabilized and conforming to **Suffix 7[(34)].**

o) Safety against Fire

A fire protection procedure is to be set up if there is to be any flame cutting, burning, heating, riveting or any operation that could start a fire. For precautions to be observed during welding and cutting operations, reference may be made to **Suffix [7(35)].**

1) The workers should be instructed not to throw objects like hot rivets, cigarette stubs, etc, around.
2) Sufficient fire extinguishers shall be placed at strategic points. Extinguishers shall always be placed in cranes, hoists, compressors and similar places. Where electrical equipments are involved, CO2 or dry powder extinguishers shall be provided and the extinguishers shall be complied with **Suffix [7(22)]** , SS 578 Code of Practice for use and Maintenance of Portable Fire Extinguishers. (Also refer Code & Standard).

p) Riding on a load, tackle or runner shall be prohibited.

q) The load shall never be allowed to rest on wire ropes. Ropes in operation should not be touched. Wire rope with broken strand shall not be used for erection work. Wire ropes/manila ropes conforming to **Suffix [7(36)]** shall be used for guying.

r) Lifting Appliances

Precautions as laid down shall be followed.

s) Slinging

1) Chains shall not be joined by bolting or wiring links together. They shall not be shortened by tying knots. A chain in which the links are locked, stretched or do not move freely

shall not be used. The chain shall be free of kinks and twists. Proper eye splices shall be used to attach the chain hooks.

2) Pulley blocks of the proper size shall be used to allow the rope free play in the sheave grooves and to protect the wire rope from sharp bends under load. Idle sling should not be carried on the crane hook along with a loaded sling. When idle slings are carried they shall be hooked.
3) While using multi legged slings, each sling or leg shall be loaded evenly and the slings shall be of sufficient length to avoid a wide angle between the legs.

t) Riveting Operations

1) Handing rivets

Care shall be taken while handling rivets so that they do not fall, strike or cause injury to men and material below. Rivet catchers shall have false wooden bottoms to prevent rivets from rebounding.

2) Riveting dollies

Canvas, leather or rope slings shall be used for riveting dollies. Chain shall not be used for the purpose.

3) Riveting Hammers

Snaps and plungers of pneumatic riveting hammers shall be secured to prevent the snap from dropping out of place. The nozzle of the hammer shall be inspected periodically and the wire attachment renewed when born.

4) Fire Protection

The rivet heating equipment should be as near as possible to the place of work. A pail of water shall always be kept already for quenching the fire during riveting operations and to prevent fires when working near inflammable materials.

u) Welding and Gas Cutting

1) For safety and health requirements in electric gas welding and cutting operations, reference may be made to **Suffix [7(37)]** and **Suffix [7(40)].**
2) All gas cylinders shall be used and stored in the upright position only and shall be conveyed in trolleys. While handling by cranes they shall be carried in cages. The cylinders shall be marked ‘full’ or ‘empty’ as the case may be. Gas cylinders shall be stored away from open flames and other sources of heat. Oxygen cylinders shall not be stored near combustible gas, oil, grease and similar combustible materials. When the cylinders are in use, cylinder valve key or wrench shall be placed in position. Before a cylinder is moved, cylinder valve shall be closed. All cylinder valves shall be closed when the torches are being replaced or welding is stopped for some reason. The cylinder valve and connections shall not be lubricated.
3) Gas cutting and welding torches shall be lighted by means of special lighters and not with matches. The cables from welding equipment should be placed in such a way that they are not run over by traffic. Double earthing shall be provided. Before undertaking welding operations near combustible materials, suitable blanketing shall be provided and fire extinguishers kept nearby. Welding shall not be undertaken in areas where inflammable liquids and gases are stored.
4) Gas lines and compressed air lines shall be identified by suitable colour codes for easy identification, to avoid confusion and to prevent fire and explosion hazards.

7.3.13.3 Safety of Structures

a) The structure itself should be safeguarded during its erection. The first truss of the roof system shall be guyed on each side before the hoisting rope is detached from it. After the subsequent trusses and roof purlins are erected, protective guides shall be firmly established and the required wind bracings shall be erected to prevent the whole structure being blown over by a

sudden gale at night. Bracing and guying precautions shall be taken on every structure until it is complete. Guying shall be specifically done for trusses and structural components which after their erection form an erection device, on structures used for temporary material storage overloading shall be avoided.

b) Erection of columns shall be immediately followed by vertical bracing between columns before the roof structure is erected.

7.3.14 MISCELLANEOUS ITEMS

7.3.14.1 Staircase Construction

While staircase is under construction, depending on the type of construction, namely, concrete or brickwork, etc, suitable precautions shall be taken by way of support, formworks, etc, to prevent any collapse. Workmen or any other person shall not be allowed to use such staircases till they are tested and found fit for usage by the Authority/engineer-in-charge. Till the permanent handrails are provided, temporary provisions like ropes, etc, shall be provided on staircases prior to commencement of use of such staircases.

7.3.14.2 Lift Wells

Till the installation of the lift is completed, lift wells shall be protected with check boards or railings together with notice boards, danger lights, etc, to prevent persons accidentally falling into the wells. The handrails provided shall be capable of withstanding pressure exerted due to normal bumping of an individual against the same.

7.3.14.3 Timber Structure

Preventive measures against hazards in work places involving construction of timber structures shall be taken in accordance with **Suffix [7(38)].**

7.3.15 FINISHES

7.3.15.1 Painting, Polishing and Other Finishes

Only the quantity of paint, thinner and polish required for the day's work should be kept at the work spot.

a) All containers of paint, thinner and polish which are not in actual use should be closed with tight fitting lids and kept at a safe place away from the actual work site.

b) A 5 kg dry powder fire extinguisher conforming to **Suffix [7(39)]** shall be kept handy.

c) Metal receptacles with pedal operated metal lids shall be kept handy at the work site for depositing used cotton rags/waste. The contents of such receptacles shall be disposed off before the end of each day's work at a safe place, preferably by burning under proper supervision.

d) All containers of paint shall be removed from the work site and deposited in the paint store before the close of day's work. Used paintbrushes shall be cleaned and deposited in the store along with the containers.

e) Some paints/polishing and finishing materials are injurious to the health of workers. Adequate protective clothing, respiratory equipment, etc, shall be provided for the use of workers during such operations where necessary.

7.3.16 FRAGLIE FIXTURES

7.3.16.1 It shall be ensured that sufficient number of workmen and equipment are provided to carry the fragile fixtures like sanitary fittings, glass panes, etc, to prevent injury to workers due to accidental dropping of such fixtures.

7.3.17 ELECTRICAL INSTALLATIONS AND LIFTS

7.3.17.1 Temporary Electrical Wiring

a) Frayed and/or bare wires shall not be used for temporary electrical connections during construction. All temporary wiring shall be installed and supervised by a competent electrician. Adequate protection shall be provided for all electrical wiring laid on floor which may have to be crossed over by construction machinery or by the workers. All flexible wiring connecting the electrical appliances shall have adequate mechanical strength and shall preferably be enclosed in a flexible metal sheath. Overhead wires/cables shall be so laid that alley leave adequate head room.

b) All electrical circuits, other than those required for illumination of the site at night, shall be switched off at the close of day's work. The main switch board from which connections are taken for lighting, power operated machinery, etc, shall be located in an easily accessible and prominent place. No articles of clothing nor stores shall be kept at the back of or over the board or anywhere near it. One 2 kg/5 kg CO2 extinguisher or one 4/6 kg dry powder extinguisher conforming to **Suffix [7(39)]** shall be provided near the switch board.

7.3.17.2 Permanent Electrical Installations

Besides the fire safety measures for electrical installations covered under 7.3.17.1 safety in electric installations in buildings and installations of lifts shall be in accordance with 'Building Services'.

7.3.18 General Safety Requirements for Workplace

7.3.18.1 Sanitation

(a) Adquate toilet facilities shall be provided for the workers within easy access of their place of work. The total number to be provided shall be not less than one per 30 employees in any one shift.

(b) Toilet facilities shall be provided from the start of building operations, and connection to a sewer shall be made as soon as practicable.

(c) Every toilet shall be so constructed that the occupant is sheltered from view and protected from the weather and falling objects.

(d) Toilet facilities shall be maintained in a sanitary condition. A sufficient quantity of disinfectant shall be provided. Natural or artificial illumination shall be provided.

(e) An adequate supply of drinking water shall be provided, and unless connected to a municipal water supply, samples of the water shall be tested at frequent intervals by the Authority.

(f) Washing facilities shall be installed, and when practicable shall be installed, and when practicable shall be connected to municipal water supply and shall discharge to a sewer.

(g) Natural or artificial illumination shall be provided.

7.3.18.2 Fire Protection

a) In addition to the provision of fire extinguishers, as specified in this Part of the Code, other fire extinguishing equipment shall also be provided and conveniently located within the building under construction or on the building site, as required by the Authority.
   1) All fire extinguishers shall be maintained in a serviceable condition at all times and all portable fire extinguishers where required to be provided shall be charged, tested and maintained in fully operational conditions and properly tagged in conformity with requirements in **Suffix [7(22)]** , SS 578 Code of Practice for use and Maintenance of Portable Fire Extinguishers. (Also refer to Code & Standard) and all necessary guidelines regarding fire protection at workplaces followed in accordance with **Suffix [7(20)].**
   2) It shall be ensured that all workmen and supervisory staff are fully conversant with the correct operation and use of fire extinguishers provided at the construction site.

3) Telephone number of local fire brigade should be prominently displayed near each telephone provided at construction site.
4) Watch and ward services should be provided at construction sites during holidays and nights.

b) Access shall be provided and maintained at all times to all fire fighting equipment, including fire hose, extinguishers, sprinkler valves and hydrants.
1) Approach roads for fire fighting should be planned, properly maintained and kept free from blockage. Approach roads for fire fighting shall comply with Myanmar Fire Safety Code - MFSC (2020).
2) Emergency plan and fire order specifying the individual responsibility in the event of fire should be formulated and mock drills should be practiced periodically in case of large and important construction sites to ensure upkeep and efficiency of fire fighting appliances.
3) Periodical inspection should be carried out to identify any hazard and proper records maintained and follow up action taken.
4) Evaluation facilities and fire exits should be provided at all locations susceptible to fire hazards.

c) Where the building plans require the installation of fixed fire fighting equipment, such as hydrants, stand pipes, sprinklers and underground water mains or other suitable arrangements for provision of water shall be installed, completed and made available for permanent use as soon as possible, but in any case not later than the stage at which the hydrants, etc, are required for use as specified.
1) When there is any ambiguity between this code and MFSC-2020, the latter shall overrule the former. In a building under Construction, when a building is required to be equipped with rising mains, such rising mains shall be installed progressively as the building attains height during the course of construction.
2) All outlets, landing valves and inlets, water tanks and pumps, and hydrants as may be required for the system, shall be properly installed as directed by the Relevant thority (MFSD), so as to be readily operational in case of fire.
3) Breeching inlets for rising mains, numbers, size, and the locations of rising mains as well as the landing valves and their locations shall comply with Suffix [7(41)],SS 575. Breeching Inlets with instantaneous male couplings for connecting to the Fire Engine's 63.5 mm diameter standard hose shall be fitted to each rising main as follows:
(i) A two-way breeching inlet for a 100 mm bore rising main.
(ii) A four-way breeching inlet for a 150 mm bore rising main.
4) The standby fire hose shall be provided for every rising main except for those in buildings under Purpose Group (I & II) and its type, folding method and positions shall be provided as the following:
(i) The standby fire hose shall be of 63.5 mm nominal internal diameter in order to ensure that the hose coupling will fit existing coupling tail pieces. The fire hose shall be stipulated in the BS 6391.
(ii) The fire hose couplings shall be manufactured to BS specification or equivalent and of light alloy or gun-metal. The coupling shall be of type 63.5 mm and be of the instantaneous type with standard (double pull) release mechanism. The couplings shall be tied in by binding with galvanized mild steel wire and applied over a hose guard of synthetic fiber. It shall be able to withstand a minimum working pressure of 15 bars.

d) Close liaison shall be maintained with the local fire brigade, during construction of all buildings above 15 m in height and special occupancies, like educational; assembly, institutional, industrial, storage, hazardous and mixed occupancies with any of the aforesaid occupancies having area more than 500 m2 on each floor.

e) It is desirable that telephone system or other means of inter-communication system be provided during the construction of all buildings over 15 m in height or buildings having a plinth area in excess of 1000 m2.

f) All work waste, such as scrap timber, wood shavings, sawdust, paper, packing materials and oily waste shall be collected and disposed of safely at the end of each day's work. Particular care shall be taken to remove all waste accumulation in or near vertical shaft openings like stairways, lift-shaft, etc.

g) An independent water storage facility shall be provided before the commencement of construction operations for fire-fighting purposes. It shall be maintained and be available for use at all times.

h) Fire walls and exit stairways required for a building should be given construction priority. Where fire doors, with or without automatic closing devices, are stipulated in the building plans they should be hung as soon as practicable and before any significant quantity of combustible material is introduced in the building.

i) As the work progresses, the provision of permanent stairways, stairway enclosures, fire walls and other features of the completed structure which will prevent the horizontal and vertical spread of fire should be ensured.

Notes: Approved codes and Standards by Myanmar Fire Brigade, AHJ (Authority Having Jurisdiction, defined in MFSC-2020 Shall be observed when installing a fire protection system (i.e. both active & passive system). Application of approved codes and standards are essential for the effective fire protection where matching and compatibility of fireman inlet or breeching inlet, fire hose adaptor, and fire hose are one of the clear examples.

7.3.18.3 Clothing

a) It shall be ensured that the clothes worn by the workers be not of such nature as to increase the chances of their getting involved in accident to themselves or to others. As a rule, wearing of Chaddars or loose garments shall be prohibited.

b) Workers engaged in processes which splash liquid or other materials which will injure the skin shall have enough protective clothing to cover the body.

c) Individuals engaged in work involving use of naked flames (such as welding) shall not wear synthetic fiber or similar clothing which increases the risk of fire hazards.

7.3.18.4 Safety Measure Against Fall Prevention

Persons working at heights may use safety belts and harnesses. Provision of cat-walks, wire mesh, railings reduces chances of fall-ladder and scaffoldings, stagings etc, should be anchored on firm footing and should be secured and railing should be provided as far as possible. All accesses should be barricaded to prevent accidental fall in **Suffix [7(42)].**

7.3.18.5 Falling Materials Hazard Prevention

Preventive measures against falling materials hazards in work places shall be taken in **Suffix [7(43)].**

7.3.18.6 Disposal of Debris

Preventive measures against hazards relating to disposal of debris shall be taken in **Suffix [7(44)].**

7.3.19 CONSTRUCTION MACHINERY

a) Specification and requirements of construction machinery used in construction or demolition work shall conform to Suffix [7(45)].

b) For safety requirements for working with construction machinery, reference may be made to Suffix [7(46)].

c) Petroleum powered air compressors, hoists, derricks, pumps, etc, shall be so located that the exhausts are well away from combustible materials. Where the exhausts are pipes to outside the building under construction, a clearance of at least 150 mm shall be maintained between such piping and combustible material.

d) Earthing/grounding of electrically powered equipment/tools shall be ensured. Also all electric powered equipment should be switched off from mains, after completion of day's job.

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7.4 SAFETY IN DEMOLITION OF BUILDINGS

7.4.1 General

7.4.1.1 This Section lays down the safety requirements for carrying out demolition/ dismantling work.

7.4.1.2 Planning

Before beginning the actual work of demolition a careful study shall be made of the structure which is to be pulled down and also of all its surroundings. This shall, in particular, include study of the manner in which the various parts of the building to be demolished are supported and how far the stage by stage demolition will affect the safety of the adjoining structure. A definite plan of procedure for the demolition work, depending upon the manner in which the loads of the various structural parts are supported, shall be prepared and approved by the engineer-in-charge and this shall be followed as closely as possible, in actual execution of the demolition work. Before the commencement of each stage of demolition, the foreman shall brief the workmen in detail regarding the safety aspects to be kept in view.

It should be ensured that the demolition operations do not act any stage, and endanger the safety of the adjoining buildings.

No structure or part of the structure or any floor or temporary support or scaffold, side wall or any device for equipment shall be loaded in excess of the safe carrying capacity, in its then existing condition.

7.4.2 PRECAUTIONS PRIOR TO DEMOLITION

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

7.4.2.2 During nights, red lights shall be placed on or about all the barricades.

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

7.4.2.4 All the necessary safety appliances shall be issued to the workers and their use explained. It shall be ensured that the workers are using all the safety appliances while at work.

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

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

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

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

7.4.2.9 Protection of the Public

7.4.2.9.1 Safety distances to ensure safety of the public shall be clearly marked and prominently sign posted. Every sidewalk or road adjacent to the work shall be closed or protected. All main roads, which are opened, shall be kept open to the public clear and unobstructed at all times. Diversions for pedestrians shall be constructed, where necessary for safety.

7.4.2.9.2 If the structure to be demolished is more than two storeyed or 7.5 m high, measured from the side walk or street which cannot be closed or safely diverted, and the horizontal distance from the inside of the sidewalk to the structure is 4.5 m or less, a substantial sidewalk shed shall be constructed over the entire length of the sidewalk adjacent to the structure, of sufficient width with a view to accommodating the pedestrian traffic without causing congestion. The side walk shed shall be lighted sufficiently to ensure safety at all times. For detailed information reference may be made to **Suffix 7[(47)].**

A toe board of at least 1 m high above the roof of the shed shall be provided on the outside edge and ends of the sidewalk shed. Such boards may be vertical or inclined outward at not more than 45°.

Except where the roof of a sidewalk shed solidly abuts the structure, the face of the sidewalk shed towards the building shall be completely closed by providing sheating/planking to prevent falling material from penetrating into the shed.

The roof of sidewalk sheds shall be capable of sustaining a load of 73 N/mm2. Only in exceptional cases, say due to lack of other space, the storing of material on a sidewalk shed may be permitted in which case the shed shall be designed for a load of 146 N/mm2. Roof of Sidewalk shed shall be designed taking into account the impact of the falling debris. By frequent removal of loads it shall be ensured that the maximum load, at any time, on the roof of work shed is not more than 6000 N/mm2. The height of sidewalk shed shall be such as to give a minimum clearance of 2.4 m.

Sidewalk shed opening, for loading purposes, shall be kept closed at all time except during actual loading operations.

The deck flooring of the sidewalk shed shall consist of plank of not less than 50 mm in thickness closely laid and deck made watertight. All members of the shed shall be adequately braced and connected to resist displacement of members or distortion of framework.

7.4.2.9.3 When the horizontal distance from the inside of the sidewalk to the structure is more than 4.5 m and less than 7.5 m, a sidewalk shed or fence a substantial railing shall be constructed on the inside of the sidewalk or roadway along the entire length of the demolition side of the property with movable bars as may be necessary for the proper prosecution of the work.

7.4.3 PRECAUTIONS DURING DEMOLITION

7.4.3.1 Prior to commencement of work, all material of fragile nature like glass shall be removed.

7.4.3.2 All openings shall be boarded up.

7.4.3.3 Dust shall be controlled by suitable means to prevent harm to workers.

7.4.3.4 Stacking of materials or debris shall be within safe limits of the structural member. Additional supports, where necessary, shall be given.

7.4.3.5 Adequate natural or artificial lighting and ventilation shall be provided for the workers.

7.4.4 SEQUENCE OF DEMOLITION OPERATIONS

7.4.4.1 The demolition work shall be proceeded within such a way that,

a) It causes the least damage and nuisance to the adjoining building and the members of the public; and
b) It satisfies all safety requirements to avoid any accidents.

7.4.4.2 All existing fixtures required during demolition operations shall be well protected with substantial covering to the entire satisfaction of the rules and regulations of the undertakings or they shall be temporarily relocated.

7.4.4.3 Before demolition work is started, glazed sash, glazed doors and windows, etc., shall be removed. All fragile and loose fixtures shall be removed. The lath and all loose plaster shall be stripped off throughout the entire building. This is advantageous because it reduces glass breakage and also eliminates a large amount of dust producing material before more substantial parts of the buildings are removed.

7.4.4.4 All well openings which extend down to floor level shall be barricaded to a height of not less than 1 m above the floor level. This provision shall not apply to the ground level floor.

7.4.4.5 All floor openings and shafts not used for material chutes shall be floored over and be enclosed with guard rails and toe boards.

7.4.4.6 The demolition shall always proceed systematically storey by storey in the descending order. All work in the upper floor shall be completed and approved by the engineer-in-charge prior to disturbance to any supporting member on the lower floor. Demolition of the structure in sections may be permitted in exceptional cases, if proper precautions are ensured to prevent injuries to persons and damage to property.

7.4.5 WALLS

7.4.5.1 While walls of sections of masonry are being demolished, it shall be ensured that they are not allowed to fall as single mass upon the floors of the building that are being demolished so as to exceed the safe carrying capacity of the floors. Overloading of floors shall be prevented by removing the accumulating debris through chutes or by other means immediately. The floor shall be inspected by the engineer-in-charge before undertaking demolition work and if the same is found to be incapable to carry the load of the debris, necessary additional precautions shall be taken so as to prevent any possible unexpected collapse of the floor.

7.4.5.2 Walls shall be removed part by part. Stages shall be provided for the men to work on if the walls are less than one and a half brick thick and dangerous to work by standing over them.

7.4.5.3 Adequate lateral bracing shall be provided for walls which are unsound. For detailed information reference may be made to Suffix [7(47)].

7.4.6 FLOORING

7.4.6.1 Prior to removal of masonry or concrete floor adequate support centering shall be provided.

7.4.6.2 When floors are being removed, no workers shall be allowed to work in the area, directly underneath and such area shall be barricaded to prevent access to it.

7.4.6.3 Planks of sufficient strength shall be provided to give workers firm support to guard against any unexpected floor collapse.

7.4.6.4 When floors are being removed no person shall be allowed to work in an area directly underneath and access to such area shall be barricaded.

7.4.7 DEMOLITION OF STEEL STRUCTURES

7.4.7.1 When a derrick is used, care shall be taken to see that the floor on which it is supported is amply strong for the loading so imposed. If necessary, heavy planking shall be used to distribute the load to floor beam and girders.

7.4.7.2 Overloading of equipment shall not be allowed.

7.4.7.3 Tag lines shall be used on all materials being lowered or hoisted up and a standard signal system shall be used and the workmen instructed on the signals.

7.4.7.4 No person shall be permitted to ride the load line.

7.4.7.5 No beams shall be cut until precautions have been taken to prevent it from swinging freely and possibly striking to any worker or equipment or any part of the structure being demolished.

7.4.7.6 All structural steel members shall be lowered from the building and shall not be allowed to drop.

7.4.8 CATCH PLATFORM

7.4.8.1 In demolition of exterior walls of multistory structures, catch platform of sufficient strength to prevent injuries to workers below and public shall be provided, when the external walls are more than 20 m in height.

7.4.8.2 Such catch platform shall be constructed and maintained not more than 3 storeys below the storey from which exterior wall is being demolished.

7.4.8.3 Catch platform shall be capable of sustaining a live load of not less than 6100 N/m2.

7.4.8.4 Materials shall not be dumped on the catch platform nor shall they be used for storage of materials.

7.4.9 STAIRS, PASSAGEWAYS AND LADDERS

7.4.9.1 Stairs with railings, passageways and ladders shall be left in place as long as possible and maintained in a safe condition.

7.4.9.2 All ladders shall be secured against slipping out at the bottom and against movement in any direction at the top.

7.4.10 MECHANICAL DEMOLITION

When demolition is to be performed by mechanical devices, such as weight ball and power shovels, the following additional precautions may be observed:

a) The area shall be barricaded for a minimum distance of 1.5% times the height of the wall,
b) While the mechanical device is in operation, no workmen shall be allowed to enter the building being demolished,

c) The device shall be so located as to avoid falling debris, and
d) The mechanical device when being used shall not cause any damage to adjacent structure, power line, etc.

7.4.11 DEMOLITION OF CERTAIN SPECIAL TYPES AND ELEMENTS OF STRUCTURES

7.4.11.1 Roof Trusses

If a building has a pitched roof, the structure should be removed to wall plate level by hand methods. Sufficient purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively.

7.4.11.1.1 Temporary backing should be added, where necessary, to maintain stability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame should be independently and securely guyed in both directions before work starts.

7.4.11.1.2 On no account should the bottom tie of roof trusses should be cut until the principal rafters are prevented from making out ward movement.

7.4.11.1.3 Adequate hoisting gears suitable for the loads shall be provided. If during demolition any thing is to be put on the floor below the level of the truss, it shall be ensured that the floor is capable of taking the load.

7.4.11.2 Heavy Floor Beams

Heavy baulks of timber and steel beams should be supported before cutting at the extremities and should then be lowered gently to a safe working place.

7.4.11.3 Jack Arches

Where tie rods are present between main supporting beams, these should not be cut until after the arch or series of arches in the floor have been removed. The floor should be demolished in strips parallel to the span of the arch rings (at right angles to the main floor beams).

7.4.11.4 Brick Arches

Expert advice should be obtained and, at all stages of the demolition, the close supervision should be given by persons fully experienced and conversant in the type of work to ensure that the structure is stable at all times. However, the following points may be kept in view.

7.4.11.4.1 On no account should the restraining influence of the abutments be removed before the dead load of the spandrel fill and the arch rings are removed.

7.4.11.4.2 A single span arch can be demolished by hand by cutting narrow segments progressively from each springing parallel to the span of the arch, until the width of the arch has been reduced to a minimum which can then be collapsed.

7.4.11.4.3 Where deliberate collapse is feasible, the crown may be broken by the demolition ball method working progressively from edges to the centre.

7.4.11.4.4 Collapse of the structure can be effected in one action by the use of explosives. Charges should be inserted into bore holes drilled in both arch and abutments.

7.4.11.4.5 In multi-span arches, before individual arches are removed, lateral restraint should be provided at the springing level. Demolition may then proceed as for single span; where

explosives are used it is preferable to ensure the collapse of the whole structure in one operation to obviate the chance of leaving unstable portion standing.

7.4.11.5 Cantilever (Not Part of a framed structure)

Canopies, cornices, staircases and balconies should be demolished or supported before tailing down load is removed.

7.4.11.6 In-situ Reinforced Concrete

Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement should be ascertained.

Demolition should be commenced by removing partitions and external non-load bearing cladding.

7.4.11.6.1 Reinforced Concrete Beams

A supporting rope should be attached to the beam. Then the concrete should be removed from both ends by pneumatic drill and the reinforcement exposed. The reinforcement should then be cut in such a way as to allow the beam to be lowered under control to the floor.

7.4.11.6.2 Reinforced Concrete Columns

The reinforcement should be exposed at the base after restraining wire guy ropes have been placed round the member at the top. The reinforcement should then be cut in such a way as to allow it to be pulled down to the floor under control.

7.4.11.6.3 Reinforced Concrete Walls

These should be cut into strips and demolished as for columns.

7.4.11.6.4 Suspended Floors and Roofs

The slab should be cut into strips parallel to the main reinforcement and demolished strip by strip. Where ribbed construction has been used, the principle of design and method of construction should be determined before demolition is commenced. Care should be taken not to cut the ribs inadvertently.

7.4.11.7 Precast Reinforced Concrete

Due precautions shall be taken to avoid toppling over of prefabricated units or any other part of the structure and whenever necessary temporary supports shall be provided.

7.4.11.8 Prestressed Reinforced Concrete

Before commencing of the demolition work, advice of an engineering expert in such demolition shall be obtained and followed.

7.4.12 LOWERING, REMOVAL AND DISPOSAL OF MATERIALS

7.4.12.1 Dismantled materials may be thrown to the ground only after taking adequate precautions. The material shall preferably be dumped inside the building. Normally such materials shall be lowered to the ground or to the top of the sidewalk shed where provided by means of ropes or suitable tackles.

7.4.12.2 Through Chutes

7.4.12.2.1 Wooden or metal chutes may be provided for removal of materials. The chutes shall preferably be provided at the centre of the building for efficient disposal of debris.

7.4.12.2.2 Chutes, if provided at an angle of more than 45° from the horizontal, shall be entirely enclosed on all the four sides, except for opening at or about the floor level for receiving the materials.

7.4.12.2.3 To prevent the descending material attaining a dangerous speed, chute shall not extend in an unbroken line for more than two-storeys. A gate or stopper shall be provided with suitable means for closing at the bottom of each chute to stop the flow of materials.

7.4.12.2.4 Any opening into which workers dump debris at the top of chute shall be guarded by a substantial guard rail extending at least 1 m above the level of the floor or other surface on which men stand to dump the materials into the chute.

7.4.12.2.5 A toe board or bumper, not less than 50 mm thick and 150 mm high shall be provided at each chute openings, if the material is dumped from the wheel barrows. Any space between the chute and the edge of the opening in the floor through which it passes shall be solidly planked over.

7.4.12.3 Through Holes in the Floors

7.4.12.3.1 Debris may also be dropped through holes in the floor without the use of chutes. In such a case the total area of the hole cut in any intermediate floor, one which lies between floor that is being demolished and the storage floor shall not exceed 25 percent of such floor area. It shall be ensured that the storage floor is of adequate strength to withstand the impact of the falling material.

7.4.12.3.2 All intermediate floor openings for passage of materials shall be completely enclosed with barricades or guard rails not less than 1.0 m high and at a distance of not less than 1.0 m from the edge of general opening. No barricades or guard rails shall be removed until the storey immediately above has been demolished down to the floor line and all debris cleared from the floor.

7.4.12.3.3 When the cutting of a hole in an intermediate floor between the storage floor and the floor which is being demolished makes the intermediate floor or any portion of it unsafe, then such intermediate floor shall be properly shored. It shall also be ensured that the supporting walls are not kept without adequate lateral restraints.

7.4.12.4 Removal of Materials

7.4.12.4.1 As demolition work proceeds, the released serviceable materials of different types shall be separated from the unserviceable lot at suitable time intervals and properly stocked clear of the spots where demolition work is being done.

7.4.12.4.2 The unserviceable lot obtained during demolition shall be collected in well-formed heaps at properly selected places, keeping in view safe conditions for workmen in the area. The height of each unserviceable lot shall be limited to ensure its toppling over or otherwise endangering the safety of workmen or passersby.

7.4.12.4.3 The unserviceable lot shall be removed from the demolition site to a location as required by the local civil authority. Depending on the space available at the demolition site, this operation of conveying lot to its final disposal location may have to be carried out a number of times during the demolition work. In any case, the demolition work shall not be considered as completed and the area declared fit for further occupation till all the lot has been carried to its final disposal location and the demolition areas tidied up.

7.4.12.4.4 Materials which are likely to cause dust nuisance or undue environmental pollution in any other way, shall be removed from the site at the earliest and till then they shall be suitable covered. Such materials shall be covered during transportation also.

7.4.12.5 Following other requirements should also be met:

a) Glass and steel should be dumped or buried separately to prevent injury.
b) Workman should be provided with suitable protective gears for personal safety during works, like safety helmets, boots, hand gloves, goggles, special attire, etc.
c) Debris removal work should be carried out during day. In case poor visibility artificial light may be provided.
d) The debris should first be removed from top. Early removal from bottom or sides of dump may cause collapse of debris, causing injuries.

7.4.13 MISCELLANEOUS

7.4.13.1 No demolition work should be carried out during night as far as possible, especially when the structure to be demolished is in an inhabited area. If such night work has to be done, additional precautions by way of additional red warning signals, working lights and watchmen, shall be provided to avoid any injury to workers and public. Demolition work shall not be carried out during storm and heavy rain.

7.4.13.2 Warning devices shall be installed in the area to warn the workers in case of any danger.

7.4.13.3 Safety devices like industrial safety helmets conforming to the Suffix [7(26)] and goggles made of celluloid lens shall be issued to the workers. Foreman-in-charge of the work areas shall ensure that all the workers are wearing the safety devices before commencing any work.

7.4.13.4 Construction sheds and tool boxes shall be so located as to protect workers from injuries from the falling debris.

7.4.13.5 Where there is a likelihood of injuries to hands of workers when demolishing RCC/steel structures, etc, gloves of suitable materials shall be worn by workers.

7.4.13.6 Sufficient protection by way of both overhead cover and screens shall be provided to prevent injuries to the workers and the public.

7.4.13.7 Safety belts or harness shall be used by workers when working at higher levels.

7.4.13.8 Grading of Plot

When a building has been demolished and no building operation has been projected or approved, the vacant plot shall be filled, graded and maintained in conformity to the established street grades at curb level. The plot shall be maintained free from the accumulation of rubbish and all other unsafe and hazardous conditions which endangers the life or health of the public and provisions shall be made to prevent the accumulation of water or damage to any foundations on the premises or the adjoining property.

7.4.14 FIRST-AID

7.4.14.1 A copy of all pertinent regulations and notices concerning accidents, injury and first-aid shall be prominently exhibited at the work site.

7.4.14.2 Depending on the scope and nature of the work, a person, qualified in first-aid shall be available at work site to render and direct first-aid to casualties. He shall maintain a list of individuals qualified to serve in first aid work. Enough first-aid kit, including a stretcher and a cot with accessories shall be provided at site. A telephone may be provided to first-aid assistant with telephone numbers of the hospitals prominently displayed.
Complete reports of all accidents and action taken thereon shall be forwarded to the competent authorities.

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7.5 MAINTENANCE MANAGEMENT, REPAIRS, RETROFITTING AND STRENGTHENING OF BUILDINGS

7.5.1 MAINTENANCE MANAGEMENT

7.5.1.1 Maintenance management of building is the art of preserving over a long period what has been constructed. Whereas construction stage lasts for a shortperiod, maintenance continues for comparatively very large period during the useful life of building. Inadequate or improper maintenance adversely affects the environment in which people work, thus affecting the overall output. In the post construction stage the day to day maintenance or upkeep of the building shall certainly delay the decay of the building structure.Though the building may be designed to be very durable it needs maintenance to keep it in good condition.

7.5.1.2 Terminology

For the purpose of this Section, the following definitions shall apply.

7.5.1.2.1 Maintenance - The combination of all technical and associated administrative actions intended to retain an item in or restore it to a state in which it can perform its required function.

7.5.1.2.2 Maintenance Management - The organization of maintenance within an agreed policy. Maintenance can be seen as a form of 'steady state' activity.

7.5.1.2.3 Building Fabric - Elements and components of a building other than furniture and services.

7.5.1.2.4 Building Maintenance - Work undertaken to maintain or restore the performance of the building fabric and its services to provide an efficient and acceptable operating environment to its users.

7.5.1.2.5 House Keeping - The routine recurring work which is required to keep a structure in good condition so that it can be utilized at its original capacity and efficiency along with proper protection of capital investment, throughout its economic life.

7.5.1.2.6 Owner - Person or body having a legal interest in a building. This includes freeholders, leaseholders or legal occupants and gives rise to liabilities in respect of safety or building condition. In case of lease or legal occupants, as far as ownership with respect to the structure is concerned, the structure of a flat or structure on a plot belongs to the allottee/lessee till the allotment/lease subsists.

7.5.1.2.7 Confined Space - Space which may be inadequately ventilated for any reason and may result in a deficiency of oxygen, or a build-up of toxic gases, e.g. closed tanks, sewers, ducts, closed and unventilated rooms, and open topped tanks particularly where heavier than air gases or vapours may be present.

7.5.1.3 Building Maintenance

7.5.1.3.1 General

Any building (including its services) when built has certain objectives and during its total economic life, it has to be maintained. Maintenance is a continuous process requiring a close watch and taking immediate remedial action. It is interwoven with good quality of house keeping. It is largely governed by the quality of original construction. The owners, engineers, constructors, occupants and the maintenance agency are all deeply involved in this process and share a responsibility. Situation in which all these agencies merge into one is ideal and most satisfactory. There are two processes envisaged, that is, the work carried out in anticipation of failure and the work carried out after failure. The former is usually referred to as preventive

maintenance and the latter as corrective maintenance. The prime objective of maintenance is to maintain the performance of the building fabric and its services to provide an efficient and acceptable operating environment to its users.

7.5.1.3.1.1 Maintenance in general term can be identified in the following broad categories.

(a) Cleaning and servicing — This is largely of preventive type, such as checking the efficacy of rain water gutters and servicing the mechanical and electrical installations. This covers the house keeping also.

(b) Rectification and repairs —This is also called periodical maintenance work undertaken by, say, annual contracts and including external replastering, internal finishing etc.

(c) Replacements — This covers major repair or restoration such as reproofing or re-building defective building parts.

7.5.1.3.2 Factors Affecting Maintenance

7.5.1.3.2.1 Maintenance of the buildings is influenced by the following factors:

a) **Technical factors -** These include age of building, nature of design, material specifications, past standard of maintenance and cost of postponing maintenance.

b) **Policy -** A maintenance policy ensures that value for money expended is obtained in addition to protecting both the asset value and the resource value of the buildings concerned and owners.

c) Financial and economic factors made to Suffix[7(49) and [7(50)].

d) **Environmental -** All buildings are subject to the effects of a variety of external factors such as air, wind precipitation, temperature etc. which influence the frequency and scope of maintenance.

e) The fabric of building can be adversely affected as much by the internal environment as by the elements externally. Similar factors of humidity, temperature and pollution should be considered. Industrial buildings can be subject to many different factors subject to processes carried out within. Swimming pool structures are vulnerable to the effects of chlorine used in water.

User - The maintenance requirements of buildings and their various parts are directly related to the type and intensity of use they receive.

7.5.1.3.2.2 Influence of design

The physical characteristics, the life span and the aesthetic qualities of any building depend on the considerations given at the design stage. All buildings, however well designed and conscientiously built, will require repair and renewal as they get older. However, for better performance of the building envelop, the following are the ways to minimize troubles at the later stage.

a) Minimize defects during construction and design,

b) Detail and choose materials during construction so that the job of maintenance is less onerous.

7.5.1.3.2.2.1 In addition to designing a building for structural adequacy, consideration should also be given to environmental factors such as moisture, natural weathering, corrosion and chemical action, user wear and tear, pollution, flooding, subsidence, earthquake, cyclones etc.

7.5.1.3.2.2.2 A list of common causes for maintenance problems is given in Annex B for guidance. However, no such list is likely to be entirely comprehensive.

7.5.1.3.3 Maintenance Policy

The policy should cover such items as the owner's anticipated future requirement for the building taking account of the building's physical performance and its functional suitability. This may lead to decisions regarding:

a) the present use of the building anticipating any likely upgradings and their effect on the life cycles of existing components or engineering services; and
b) a change of use for the building and the effect of any conversion work on the life cycles of existing components or engineering services.

7.5.1.3.4 Maintenance Work Programmes

The programming of maintenance work can affect an owner or his activities in the following ways:

a) maintenance work should be carried out at such times as are likely to minimize any adverse effect on output or function.
b) programme should be planned to obviate as far as possible any abortive work. This may arise if upgrading or conversion work is carried out after maintenance work has been completed or if work such as rewiring is carried out after redecoration.
c) any delay in rectifying a defect should be kept to a minimum only if such delay is likely to affect output or function. The cost of maintenance increases with shortening response times.
d) maintenance work, completed or being carried out should comply with all statutory and other legal requirements.

7.5.1.3.5 Maintenance Guides

An owner responsible for a large number of buildings may have established procedures for maintenance. When an owner is responsible for the maintenance of only one building or a small number of buildings, the preparation of a guide tailored to suit each particular building, can offer significant advantages. Such a guide should take into account the following:

a) type of construction and residual life of the building, and
b) environment and intensity of use see (7.5.1.3.2)

The guide may form part of a wider manual covering operational matters.

7.5.1.3.6 Planning of Maintenance Work

Work should take account of the likely maintenance cycle of each building element and be planned logically, with inspections being made at regular intervals. Annual plans should take into account subsequent years' programmes to incorporate items and to prevent additional costs. It should be stressed that the design of some buildings can lead to high indirect costs in maintenance contracts and therefore, careful planning can bring financial benefits. Decisions to repair or replace should be taken after due consideration.

7.5.1.3.7 Feedback

7.5.1.3.7.1 Feedback is normally regarded as an important procedure of providing information about the behavior of materials and detailing for the benefit of the architect/engineer designing new buildings, which will result in lessening maintenance costs. It is an equally valuable source of information for the persons responsible for maintenance. Every maintenance organization should develop a sample way of communicating it's know how, firstly for benefit of others in the organization and secondly for the benefit of the building industry as a whole. There should be frank and recorded dialogue on an on-going basis between those who occupy and care for buildings and those who design and construct them.

7.5.1.3.7.2 Feedback should aim at the following:

a) User satisfaction,
b) Continuous improvement, and
c) Participation by all.

7.5.1.3.7.3 Source of information

The information on feedback can be obtained from the following:

a) Occupants,
b) Inspections,
c) Records, and
d) Discussions.

7.5.1.3.8 Means of Effecting Maintenance

7.5.1.3.8.1 Responsibility

Some maintenance work will be carried out by the occupier of a building or by the occupier's representative. In the case of leasehold or similar occupation not all maintenance may be the responsibility of occupier. Responsibility of common areas may be clearly defined.

7.5.1.3.8.2 Maintenance work sub-divided into major repair, restoration, periodical and routine or day-to-day operations will be undertaken by one of the following:

a) Directly employed labour,
b) Contractors, and
c) Specialist contractors under service agreement or otherwise.

7.5.1.3.8.3 The merits of each category for typical maintenance work must be considered because optimum use of resources appropriate to tasks in a given situation is an important element of policy.

7.5.1.3.8.4 The success of contracting out depends on the nature of the services, conditions in which contracting is undertaken (the tendering process), how the contract is formulated and subsequent monitoring of service quality. The important consideration in the decision to contract out is whether a contractor can ensure a socially desirable quantity and quality of service provision at, a reasonable cost to the consumers.

7.5.1.4 Access

7.5.1.4.1 General

All maintenance activities including any preliminary survey and inspection work require safe access and in some situations this will have to be specially designed. Maintenance policy, and maintenance costs, will be much influenced by ready or difficult access to the fabric and to building services. Special precautions and access provisions may also need to be taken for roof work or for entry into confined spaces such as ducts or voids.

7.5.1.4.2 Access Facilities

7.5.1.4.2.1 Permanent accessibility measures should be provided at the design stage only for all the areas for safe and proper maintenance. It is a matter on which those experienced in the case of the building can make an important contribution at design stage in the interest of acceptable maintenance costs.

7.5.1.4.2.2 A wide variety of temporary access equipment may appropriately be provided for maintenance work, ranging from ladders to scaffoldings or powered lift platforms.

7.5.1.4.2.3 Wherever possible it is better to provide permanent access facilities such as fixed barriers, ladders, and stairways. When such permanent access facilities are provided necessary arrangement may be included in maintenance plans for their regular inspection, maintenance and testing.

7.5.1.4.2.4 All personnel employed for carrying out maintenance should be provided with the necessary protective clothing and equipment and instructed in its use.

7.5.1.4.2.5 When physical access is not possible in situations such as wall cavities, drains etc, inspections may be made with the aid of closed circuit television or optical devices such as endoscopes.

7.5.1.4.3 Access to Confined Spaces

7.5.1.4.3.1 Ventilation

Special precautions need to be taken when entering a confined space. Such confined spaces should be adequately ventilated, particularly before being entered, to ensure that they are free from harmful concentrations of gases, vapour sand other airborne substances and that the air is not deficient in oxygen.

7.5.1.4.3.2 Lighting

Good lighting is necessary in order that maintenance work can be carried out satisfactorily. This is particularly important in confined spaces. When the normal lighting is inadequate it should be supplemented by temporary installations. These should provide general and spot illumination as appropriate.

7.5.1.5 Records

7.5.1.5.1 General

Good records can save owners and users/occupiers much unnecessary expense and reduce potential hazards in exploration work when faults arise.

7.5.1.5.2 Use of Building Records

7.5.1.5.2.1 All personnel involved in the maintenance of the building should be made aware of the existence of the building records.

7.5.1.5.2.2 Known hazardous areas should be explicitly marked on the records as well as being marked on site and should be pointed out to such personnel together with any system of work adopted for use in such areas.

7.5.1.5.2.3 Records are of value only if they are kept up to date and arrangements for this should be included in any provision that may be made for records.

7.5.1.5.2.4 Records should be readily accessible for use and the place of storage should take into account the form of the records and the conditions needed to keep them from damage of any kind. It is recommended that a duplicate set of records is kept in a secure place other than building itself and is kept up to date.

7.5.1.5.3 Maintenance Records

Following should be typical contents of the maintenance records:

a) A brief history of property, names and addresses of consultants and contractors.

b) Short specifications, constructional processes, components, material finishes, hidden features, special features etc.
c) "As built" plans and as subsequently altered with sections, elevations and other detailed drawings.
d) Foundation and structural plans/sections such as concrete reinforcement drawings.
e) Detail specification of all materials incorporated, for example, concrete mix, species and grades of timber etc. Potentially hazardous materials and types or methods of construction that under some circumstances may become hazardous may be identified.
f) Information on housekeeping and routine maintenance with details of internal and external surfaces and decorations, schedule of cleaning, inspection and maintenance.
g) Means of operating mechanical, electrical and plumbing installations.
h) Description of renovations, extensions, adaptations and repair to each element.
i) All plant, machinery and propriety articles including manufacturers, trade literature and instructions for installation, use and maintenance.
j) Methods of work used in construction such as assembly of prefabricated units.
k) All information related to fire such as:
    1) Location and service arrangements of all fire alarm and call points;
    2) Location and service arrangements of all extinguishers, hose reels and other fire fighting installations;
    3) Location of all fire compartment walls, doors, floors and screens;
    4) Location of all areas of exceptional fire hazard;
    5) Fire escape routes;
    6) Details of application of any fire protection treatment; and
    7) Location details and description of any installation for smoke control or protection of escape routes.
l) There should be a wall chart showing at a glance the various operations which have to be undertaken. Line drawings of buildings are always useful.
m) Records of security measures should be known to authorized personnel only.
n) Where no records exist, information should be slowly built up as it becomes available during the course of maintenance work.
o) Computerized data can be used for storing information may be preferred.

7.5.1.5.4 Mechanical Records

7.5.1.5.4.1 Documentation

Documentation should record the following as installed:

a) The location, including level if buried, of all public service connections (for example, fuel gas and cold water supplies) together with the points of origin and termination, size and materials of pipes, line pressure and other relevant information;
b) the layout, location and extent of all piped services showing pipe sizes, together with all valves for regulation, isolation and other purposes as well as the results of all balancing, testing and commissioning data;
c) the location, identity, size and details of all apparatus and all control equipment served by, or associated with, each of the various services together with copies of any test certificates for such apparatus where appropriate. The information with respect to size and details may be presented in schedule form;
d) the layout, location and extent of all air ducts showing dampers and other equipment, acoustic silencers, grilles, diffusers or other terminal components. Each duct and each terminal component should be marked with its size, the air quantity flowing and other relevant balancing data, and
e) The location and identity of each room or space housing plant, machinery or apparatus.

7.5.1.5.4.2 Drawings

Drawings should record the following as installed:

a) detailed general arrangements of boiler houses, machinery spaces, air handling plants, tank rooms and other plant or apparatus, including the location, identity, size and rating of each apparatus, The information with respect to the size and rating can be presented in schedule form;
b) Isometric or diagrammatic views of boiler houses, plant rooms, tank rooms and similar machinery, including valve identification charts. It is useful to frame and mount a copy of such drawings on the wall of the appropriate room, and
c) comprehensive diagrams that show power wiring and control wiring and/or pneumatic or other control piping including size, type or conductor or piping used and identifying the terminal points of each.

7.5.1.5.5 Electrical Records

Documentation should record the following including locations, as installed:

a) main and submain cables, showing origin, route, termination, size and type of each cable; cables providing supplies to specialist equipment, for example, computers, should be identified separately; and
b) lighting conduits and final sub circuit cables, showing origin, route, termination and size of each, together with the number and size of cables within each conduit. The drawings should indicate for each conduit or cable, whether it is run on the surface or concealed, for example, in a wall chase, in a floor screed, cast in-situ, above a false ceiling etc.

These drawings should also indicate the locations of lighting fittings, distribution boards, switches, draw-in- boxes and point boxes, and should indicate circuitry:

a) location and purpose of each emergency lighting fitting including an indication of the circuit to which it is connected;
b) single and three phase power conduits and final sub-circuit cables showing; locations of power distribution boards, motors, isolators, starters, remote control units, socket outlets and other associated equipment.
c) other miscellaneous equipment, conduits and cables;
d) lightening conductor, air terminals, conductors, earth electrodes and test clamps;
e) location of earth tapes, earth electrodes and test points other than those in (f); and
f) cables providing earth circuits for specialist equipment, for example computers, should be identified separately,

Documentation should also include, when applicable.

a) distribution diagrams or schedules to show size, type and length (to within 1m) of each main and sub main cable, together with the measured earth continuity resistance of each;
b) schedule of lighting fittings installed stating location, manufacturer and type or catalogue number together with the type or manufacturer's reference, voltage and wattage of the lamp installed;
c) schedule of escape and emergency lighting fittings installed starting location, manufacturer, type or catalogue number together with the type or manufacturer's reference, voltage and wattage of the lamp installed. For battery systems the position of the battery, its ampere hour rating and battery system rated endurance in hours should be stated;
d) records of smoke detectors, sprinklers, fire precautions;
e) incoming supply details; the type of system, voltage, phases, frequency, rated current and short circuit level, with the details of the supply protection and time of operation as appropriate;
f) main switchgear details; for purpose made equipment this should include a set of manufacturers' drawings and the site layout;

g) transformer, capacitor and power plant details; the leading details should be given, for example, for transformers the V.A rating, voltages and type of cooling; and
h) Completion certificate

7.5.1.6 Inspections

7.5.1.6.1 General

Regular inspections are actual part of the procedures for the maintenance of buildings. They are needed for a variety of purposes and each purpose requires a different approach if it is to be handled with maximum economy and efficiency. A more detailed inspection covering all parts of a building is needed to determine what work should be included in cyclic and planned maintenance programme.

7.5.1.6.2 Frequency of Inspection

Inspection should be carried out at the following frequencies:

a) **Routine —** Continuous regular observations should be undertaken by the building user as part of the occupancy of building. Feedback resulting from this type of observation should be encouraged.
b) **General —** Visual inspections of main elements should be made annually under the supervision of suitably qualified personnel at appropriate times.
c) **Detailed —** The frequency of full inspection of the building fabric by suitably qualified personnel should not normally exceed a 5 year period.

7.5.1.6.2.1 Inspection schedule

The preparation of a specific schedule should be encouraged. Once prepared, it can be used for subsequent inspections.

7.5.1.6.3 Inspection of Engineering Services

Engineering services generally have a shorter life expectancy than building fabric and because of their dynamic function should be subjected to more frequent inspections and maintenance.

7.5.1.6.3.1 Inspection of services should be carried out for three purposes as follows:

a) to check if maintenance work is required,
b) to check if maintenance work is being adequately carried out, and
c) for safety reasons to comply with statutory requirements and if required, with recommendations of other relevant organizations.

7.5.1.6.3.2 The frequency of inspections for purpose (a) will depend upon types of plant and system manufacturer's recommendations and subjective judgment. Frequencies for purpose (b) should be carried out on an annual basis.

7.5.1.6.3.3 Method of inspection

The limited life of building services means it is important to record their residual life so that their replacement can be budgeted for, and inspection methods should be arranged accordingly. A checklist of items of plant to be inspected should be considered. Detailed specifications of how inspections should be carried out are necessary because a simple visual inspection is unlikely to show whether plant is operating correctly and efficiently.

Inspections frequently necessitate the use of appropriate instruments by competent persons. An example of this is the inspections carried out to check compliance with statutory requirements.

When instruments are used it is important that adequate training is provided in the use of the instruments and the interpretation of the results.

7.5.1.6.4 Records of all inspections should be kept.

7.5.1.6.5 Inspection Report

Inspection report may be prepared in the format as given in Annex C.

7.5.1.7 Maintenance of Electrical Appliances

7.5.1.7.1 Planning of Maintenance Work

7.5.1.7.1.1 If the authorized person has complete knowledge of the electrical appliances to be worked upon, then safety will be more assured. If the person attending to the job is not technically competent to handle the job then more careful planning is required before hand.

7.5.1.7.1.2 Repetitive nature of jobs involve little or no pre-planning whereas infrequent nature of jobs may need careful planning even if the person attending the job is technically competent.

7.5.1.7.1.3 Planned routine maintenance will facilitate continued safe and acceptable operation of an electrical system with a minimum risk of breakdown and consequent interruption of supply.

7.5.1.7.1.4 As far as the electrical equipments/installations are concerned, it is not possible to lay down precise recommendations for the interval between the maintenance required. The recommendation for frequency of maintenance in this regard from the manufacturer is more relevant. The manufacturer should be requested to specify minimum maintenance frequency under specified conditions. These intervals depend greatly upon the design of the equipment, the duties that it is called onto perform and the environment in which it is situated.

7.5.1.7.2 Following two types of maintenance are envisaged

7.5.1.7.2.1 Routine maintenance

Routine maintenance of the electrical equipments goes along with the regular inspections of the equipments. Inspections shall reveal the undue damage and excessive wear to the various components. Examination of the equipment shall reveal any need for conditioning of the contact system, lubrication and adjustment of the mechanisms.

7.5.1.7.2.2 Post fault maintenance

When there is a breakdown in the system and certain parts are identified for the replacement and then the maintenance/repair of the defective part away from the operating environment is covered under post fault maintenance.

7.5.1.7.3 Guidelines for the Maintenance of Electrical Appliances

7.5.1.7.3.1 Uninterrupted and hazard free functioning of the electrical installations are the basic parameters of maintenance. The equipment should be restored to correct working conditions. Special attention should be paid to the items and settings that might have been disturbed during the operational phase. Loose and extraneous equipment or wiring give rise to potential safety hazards. All covers and locking arrangements should be properly checked and secured to achieve original degree of protection.

7.5.1.7.3.2 Guidelines to be followed for the maintenance of electrical equipments to ensure their smooth functioning are given in Annex D.

7.5.1.8 Operating and Maintenance Manuals

The engineering services within buildings frequently are dynamic, involving complex systems of integrated plant items. Operation of such plant can require detailed knowledge and direction. Maintenance can also require extensive information to be available. It is, therefore, important to have suitable operating and maintenance manuals to provide the necessary guidance. These should be included as part of the contractual requirements for new installations and should ideally be prepared as reference documents for existing installations where no such information exists.

7.5.1.9 For details on labour management concerning building maintenance, reference shall be made to **Suffix [7(49)].**

7.5.1.10 For details on financial management concerning building maintenance, reference shall be made to **Suffix [7(50)].**

7.5.2 PREVENTION OF CRACKS

7.5.2.1 Cracks in buildings are of common occurrence. Abuilding component develops cracks whenever stress in the component exceeds its strength. Stress in a building component could be caused by externally applied forces, such as dead, imposed, wind or seismic loads, or foundation settlement or it could be induced internally due to thermal movements, moisture changes, chemical action, etc.

7.5.2.2 Cracks could be broadly classified as structuralor non-structural. Structural cracks are those which are due to incorrect design, faulty construction or overloading and these may endanger the safety of a building. Extensive cracking of an RCC beam is an instance of structural cracking. Non-structural cracks are mostly due to internally induced stresses in building materials and these generally do not directly result in structural weakening. In course of time, however, sometime non-structural cracks may, because of penetration of moisture through cracks or weathering action, result in corrosion of reinforcement and thus may render the structure unsafe. Vertical cracks in along compound wall due to shrinkage or thermal movement is an instance of non-structural cracking. Non-structural cracks, normally do not endanger the safety of a building, but may look unsightly, or may create an impression of faulty work or may give a feeling of instability. In some situations, cracks may, because of penetration of moisture through them, spoil the internal finish, thus adding to cost of maintenance.It is, therefore, necessary to adopt measures of prevention or minimization of these cracks.

7.5.3 REPAIRS AND SEISMIC STRENGTHENING OF BUILDINGS

7.5.3.1 General Principles and Concepts

7.5.3.1.1 Non-structural/Architectural Repairs

7.5.3.1.1.1 The buildings affected by earthquake may suffer both non-structural and structural damages. Non-structural repairs may cover the damages to civil andelectrical items, including the services in the building.Repairs to non-structural components need to be taken up after the structural repairs and retrofitting work are carried out. Care should be taken about the connectiondetails of architectural components to the main structural components to ensure their stability.

7.5.3.1.1.2 Non-structural and architectural components get easily affected/ dislocated during the earthquake.

These repairs involve one or more of the following:

a) Patching up of defects such as cracks and fall of plaster;
b) Repairing doors, windows, replacement of glass panes;
c) Checking and repairing electric conduits/ wiring;

d) Checking and repairing gas pipes, water pipes and plumbing services;
e) Rebuilding non-structural walls, smoke himneys, parapet walls, etc;
f) Replastering of walls, as required;
g) Rearranging disturbed roofing tiles;
h) Relaying cracked flooring at ground level; and
i) Redecoration – white washing, painting, etc.

The architectural repairs as stated above do not restore the original structural strength of structural components in the building and any attempt to carry out only repairs to architectural/non-structural elements, neglecting the required structural repairs, may have serious implications on the safety of the building. The damage would be more severe in the event of the building being shaken by a similar shock because original energy absorption capacity of the building would have been reduced.

7.5.3.1.2 Structural Repairs/Restoration

7.5.3.1.2.1 Prior to taking up of the structural repairs for restoration of original strength and any strengthening measures, it is necessary to conduct detailed damage assessment to determine,

a) the structural condition of the building to decide whether a structure is amenable for repair; whether continued occupation is permitted; to decide the structure as a whole or a part require demolition, if considered dangerous;
b) if the structure is considered amenable for repair then detailed damage assessment of the individual structural components (mapping of the crack pattern, distress location; crushed concrete, reinforcement bending/yielding, etc). Non-destructive testing techniques could be employed to determine the residual strengthof the members; and
c) to work out the details of temporary supporting arrangement of the distressed members so that they do not undergo further distress due to gravity loads.

7.5.3.1.2.2 After the assessment of the damage of individual structural elements, appropriate repair methods are to be carried out component-wise depending on the extent of damage. The restoration work may consist of the following:

a) Removal of portions of cracked masonry walls and piers and rebuilding them in richer mortar. Use of non-shrinking mortar will be preferable.
b) Addition of reinforcing mesh on both faces of the cracked wall, holding it to the wall through spikes or bolts and then covering it, suitably, with cement mortar or micro-concrete (maximum size of aggregate limited to 6 mm or less as suitable), and may be with use of micro-reinforcement as fibre or ferro-cement.
c) Injecting cement, polymer-cement mixture or epoxy materials, which are strong in tension, into the cracks in walls.
d) The cracked reinforced concrete elements may be repaired by epoxy grouting and could be strengthened by epoxy or polymer mortar application like shotcreting, jacketing, etc.

7.5.3.1.3 Seismic Strengthening

The main purpose of the seismic strengthening is to upgrade the seismic resistance of a damaged building while repairing so that it becomes safer under future earthquake occurrences. This work may involve some of the following actions:

a) Increasing the lateral strength in one or both directions by increasing column and wall areas or the number of walls and columns.
b) Giving unity to the structure, by providing a proper connection between its resisting elements, in such a way that inertia forces generated by the vibration of the building can be transmitted to the members that have the ability to resist them. Typical important

aspects are the connections between roofs or floors and walls, between intersecting walls and between walls and foundations.

c) Eliminating features that are sources of weakness or that produce concentration of stresses in some members. Asymmetrical plan distribution of resisting members, abrupt changes of stiffness from one floor to the other, concentration of large masses and large openings in walls without a proper peripheral reinforcement are examples of defects of this kind.

d) Avoiding the possibility of brittle modes of failure by proper reinforcement and connection of resisting members.

7.5.3.1.4 Seismic Retrofitting

Many existing buildings do not meet the seismic strength requirements of present earthquake codes due to original structural inadequacies and material degradation due to time or alterations carried out during use over the years. Their earthquake resistance can be upgraded to the level of the present day codes by appropriate seismic retrofitting techniques such as mentioned in 7.5.3.1.3.

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7.5.3.1.5 Strengthening or Retrofititng Versus Reconstruction

7.5.3.1.5.1 Replacement of damaged buildings or existing unsafe buildings by reconstruction is, generally, avoided due to a number of reasons, themain ones among them being,

a) higher cost than that of strengthening or retrofitting;

b) preservation of historical architecture; and

c) maintaining functional social and cultural environment.

In most instances, however, the relative cost of retrofitting to reconstruction cost determines the decision. As a thumb rule, if the cost of repair and seismic strengthening is less than about 50 percent of the reconstruction cost, the retrofitting is adopted. This may also require less working time and much less dislocation in the living style of the population. On the other hand reconstruction may offer the possibility of modernization of the habitat and may be preferred by well-to-do communities.

7.5.3.1.5.2 Cost wise the building construction including the seismic code provisions in the first instance,works out to be the cheaper in terms of its own safety and that of the occupants. Retrofitting an existing inadequate building may involve as much as 4 to 5 times the initial extra expenditure required on seismic resisting features. Repair and seismic strengthening of a damaged building may even be 5 to 10 times as expensive. It is, therefore, very much safe as well as cost-effective to construct earthquake resistant buildings at the initial stage itself according to the relevant seismic codes.

ANNEX A

(Section 2, Clause7. 2.2.1)

CHECK LIST FOR STACKING AND STORAGE OF MATERIALS

Sr no	Material/Component	Base			Stack				Type of Cover		
		Firm Level Ground	Hard Floor	Off-Floor	Heaps	Tiers	Flat	Vertical	Open	Open but covered	Under shed
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Cement			♦		♦					♦
2	Lime										
	a) Quick lime		♦		♦					♦	
	b) Hydrated lime			♦		♦					♦
3	Stones and Aggregates										
	a) Stones, aggregates, fly ash and cinder	♦			♦				♦		
	b) Veneering stones	♦				♦		♦	♦		
4	Bricks and Blocks	♦				♦			♦		
5	Tiles										
	a) Clay and concrete floor, wall and roof tiles	♦				♦	♦		♦		
	b) Ceramic tiles		♦			♦	♦				♦
6	Partially Pre-fabricated Wall and Roof Components										
	a) RC planks, prefabricated brick panels and ferrocement panels	♦						♦	♦		
	b) Channel units, corced units and L-panels										
	c) Waffle units, RC joists single tee and double tee	♦				♦			♦		
		♦					♦		♦		
7	Timber			♦		♦					♦
8	Steel	♦					♦		♦		
9	Aluminium Sections		♦				♦				♦
10	Doors, Windows and ventilators		♦					♦			♦
11	Roofing Sheets										
	a) AC	♦				♦	♦		♦		
	b) GI and Aluminium sheets	♦				♦	♦			♦	
	c) Plastic sheets			♦		♦	♦				♦

12	Boards like Plywood, Fibre Boards and Gypsum Boards			♦		♦	♦				♦
13	Plastic and Rubber Flooring a) Sheets in rolls										
	b) Tiles	♦						♦			♦
		♦				♦	♦				♦
14	Glass Sheets		♦					♦			♦
15	Glass Bricks/Bolcks		♦			♦					♦
16	CI, GI and AC Pipes and Fittings a) Pipes										
		♦				♦	♦		♦		
	b) CI and GI Fittings		♦				♦				♦
	c) AC Fittings		♦				♦		♦		
17	Polyethylene Pipes			♦		♦	♦				♦
18	Unplasticized PVC Pipes	♦				♦	♦		♦		
19	Bitumen, Road Tar, Asphalt, etc in Drums	♦				♦			♦		
20	Oil Paints		♦			♦					♦
21	Sanitary Appliances			♦			♦				♦

ANNEX B
(*Section 4, Clause 7.4.1.3.2.2.2*)

COMMON CAUSES FOR MAINTENANCE PROBLEMS

C-0 MAJOR CAUSES FOR MAINTENANCE PROBLEMS

C-1 FLOORS

a) Poor quality construction which includes quality of construction material and workmanship
b) Improper slopes, mainly in kitchen, bathrooms/toilets etc
c) Lack of rounding at junctions of walls with floors
d) Lack of damp proof course treatment in walls and particularly in sunken floors
e) Poor design of buildings

C-2 ROOFS

a) Inadequate roof slopes
b) Inferior quality of construction
c) Cracks on roof surfaces
d) Inadequate provision of rain water spouts
e) Blockages in grating/rain water pipes
f) Worn out felts
g) Bubbling up of tarfelt and separation of joints
h) Leakage from the openings provided on the roof

C-3 PLUMBING

a) Inadequate slopes in soil/waste pipes
b) Improper lead joints
c) Joints in walls
d) Improper junctions of stacks
e) Inadequate cleaning eyes at junction
f) Inadequate slopes in sewage pipes
g) Throwing of solid wastes in WC s
h) Lack of periodical checking and cleaning
i) Lack of motivation/education to users for proper use
j) Overflow from service tanks
k) Inferior quality of fittings and fixtures
l) Inadequate design

C-4 DRAINAGE

a) Improper surface dressing around buildings and improper upkeep of surroundings
b) Growth of wild grass and vegetation
c) Inadequate drainage system around the building
d) Inadequate slope of the drain or drainage pipes
e) Inadequate number of inspection chambers
f) Theft of manhole etc.
g) Throwing of solid waste in the open surface drains

C-5 ELECTRICAL

a) Loose connections
b) Improper earthing and earth connections
c) Damages to wires, cables and other installations
d) Under rated cables/wires and other installations

ANNEX C
(Section 4, Clause7. 4.1.6.5)
FORMAT FOR INSPECTION REPORT

Date : ……
Building/Block : .....
.....

		Condition		
		Sound	Suspect	Defective
FLOORS & STAIRCASES				
Ground Floor				
Finish				
Skirting				
Structure				
Damp-proofing				
Ceiling				
Under floors, spaces, (Suspended floors)				
Termites/insects				
Upper Floors				
Finish				
Structure				
Ceiling				
Suspended ceiling				
Staircase				
Structure				
Treads				
Finishes				
Balustrade				
Soffits				
Finishes				
ROOFING				
Flat/Pitched				
Finish				
Insulation				
Structure				
Roof lights/glazing				
Parapets				
Cutters				
Rain Water Pipes				
Roof interiors (Pitched)				
Growth of Vegetation				
SANITARY INSTALLATION				
Plumbing				
Fittings/Pipings, WC’s				
Taps				
Sinks				
Basins				
Urinals				
Cisterns				
Geysers				
Sewage Disposal				
Soil Pipes				

Manholes Sewerlines **Driange** Gully chambers Sewers Surface drains Inspection chambers Structural movement Failure of material Design or construction defects Overhead Tanks/Underground Sumps/terrace Tanks Septic Tanks **Remarks**				

ANNEX D
(Section 4, Clause 7.4.1.7.3.2)
GUIDELINES FOR MAINTENANCE OF ELECTRICAL EQUIPMENTS

E-1 In case of electrical appliances, manufacturer's instructions for the usage and maintenance of the equipment should be strictly followed.

E-2 The detailed/working drawings of all the components of electrical installations should always be available with the maintenance unit. Following records should be available.

(a) Manufacture's name
(b) Nameplate of the requirement and its salient features such as capacity, rating etc.
(c) Manufacturer's recommendations regarding availability/usage of spare parts.
(d) Manufacturer's recommendations for periodical maintenance and post fault maintenance.
(e) Details of the maintenance operations performed in the past.

E-3 Care should be taken while selecting replacement parts. The spare parts should be correct and suitable, preferably as recommended by the manufacturer of the installation. During the placement of order for the supply of spare parts, nameplate particulars and serial number should be quoted.

E-4 The space where the equipment is kept should be clean and properly ventilated. Equipment should not be disturbed needlessly. Before cleaning, the equipment should be made dead. For internal cleaning a section cleaner should be used.

E-5 Covers and doors should not be left open unnecessarily during maintenance. Afterwards they should be promptly and correctly closed and locked.

E-6 Before removing the covers and connections, all covers and cable terminations should be marked to ensure correct replacements. Disturbed connections and temporary connections should be marked to facilitate re-connection. Temporary connections and markings should be removed before the installation is put to use.

E-7 Those connections which have not been disturbed should also be checked for soundness and overheating.

E-8 All insulations should be regularly checked. Solid insulations should be checked for cracks and other defects. Fibrous and organic insulations should be checked for sign of blistering, delamination and mechanical damage. For insulating oils the interval between tests should be carried out as per the recommendations of the manufacturer and keeping the adverse environmental conditions in mind.

E-9 It should be ensured that the earthing connections are sound and all contact screws are tight.

E-10 During the examination of interlocks it is necessary to take precautions to prevent danger to plant or persons in the event of malfunction or inadvertent operation. A person responsible for checking and maintaining any interlock system should have thorough knowledge of the extent, nature and function of the interlock.

E-11 If the equipment is ventilated then it should be ensured that the airflow is smooth and not restricted. If filters are provided, they should be cleaned or replaced as necessary.

E-12 The standby system for tripping and closing supplies should always be kept in good order. Indicators and alarms should be maintained in time with the manufacturer's instructions.

E-13 Tools, spares and instruments should be stored near to the installation. These should be regularly checked against an inventory.

E-14 Before the start of maintenance of the circuit switches it should be ensured that all incoming and outgoing main auxiliary circuits are dead and remain so during the maintenance. Overheating of the circuit switches is the root cause for faults. Overheating may be caused by inadequate ventilation, overloading, loose connection, insufficient contact force and malalignment.

E-15 Some circuit breakers are not intended to be maintained, such as miniature circuit breakers (MCBS). Such items should not be dismantled for maintenance. These should be renewed periodically.

E-16 For the maintenance of fuses periodical inspection should be done for correct rating, security, overheating and correct location/orientation. Element of renewable fuses should be renewed when the deterioration is apparent. The availability and correct replacement of fuse links should be ensured.

E-17 If a fuse link of certain rating has failed and is replaced, then all fuse-links of same rating apparently subjected to the fault should be destroyed and replaced by new fuse links.

E-18 In order to be reasonably sure that circuit breaker is capable of operation when required, these should be tripped and reclosed at regular intervals. Tripping should be proved manually and where possible electrically via the protective relay contacts. The leakage of oil, sign of corrosion, and any unusual smell which may indicate over-heating should be detected through inspections.

E-19 Timing devices are mostly designed for specialist maintenance. These should not be dismantled for maintenance or overhaul purposes unless specifically recommended by the manufacturers'. Actual timing periods should be verified with set values and application requirements.

E-20 In case of cable boxes and terminations, security of mounting and earthing should be examined. Exposed tails should be inspected for good conditions of insulation and freedom from moisture.

E-21 Battery cells should be inspected for shedding of active material, sedimentation and buckling of plates. Level of electrolyte should be regularly checked and the level should be corrected with distilled water.

The following list of Suffixes record those standards which are acceptable as ‘accepted good practice’ and ‘accepted good standards’ in the fulfillment of the requirements of the Code. The latest version of a standard shall be adopted at the time of enforcement of the Code. The standards listed may be used by the Authority as a guide in conformance with the requirement of the referred clause in the Code.

Suffixes

[7(1)]	IS 16416 : 2016	Construction project management: Project formulation and appraisal .Guidelines
[7(2)]	IS 14580	Use of network analysis for project management
2.1	(Part 1) :1998	Management, planning, review, reporting and termination procedures
2.2	(Part 2) : 2006	Use of graphic techniques
[7(3)]	IS 15883 (Part 6)	Guidelines for construction 2015 project management: Part 6 Scope management
[7(4)]	IS 15883 (Part 7)	Guidelines for construction project management: Part 7 Procurement management (under preparation)
[7(5)]	IS 15883 (Part 2)	Guidelines for construction 2013 project management: Part 2 Time management
[7(6)]	IS 15883 (Part 3)	Guidelines for construction 2015 project management: Part 3 Cost management
[7(7)]	IS 15883 (Part 4)	Guidelines for construction 2015 project management: Part 4 Quality management
[7(8)]	IS 15883 (Part 8)	Guidelines for construction 2015 project management Part 8 Risk management
[7(9)]	IS 15883 (Part 9)	Guidelines for construction project management Part 8 Communication management (under preparation)
[7(10)]	IS 15883 (Part 10)	Guidelines for construction project management Part 10 Human resource management (under preparation)
[7(11)]	IS 15883 (Part 5)	Guidelines for construction 2013 project management Part 5 Health and safety management
[7(12)]	IS 15883 (Part 11)	Guidelines for construction project management Part 11 Sustainability management (under preparation)
[7(13)]	IS 15883 (Part 12)	Guidelines for construction 2016 project management Part 12 Integration management

[7(14)] Components of Elements

14.1 Foundations

14.1.1 IS 1080 : 1985	Code of practice for design and construction of shallow foundations on soils (other than raft, ring and shell) (second revision)
14.1.2 IS 1904 : 1986	Code of practice for design and construction of foundations in soils: General requirements (third revision)

14.1.3	IS 2911	Code of practice for design and construction of pile foundations
	(Part 1/Sec 1)	Concrete piles, Section 1 2010 Driven cast in-situ concrete piles (second revision)
	(Part 1/Sec 2)	Concrete piles, Section 2 2010 Board cast in-situ concrete piles (second revision)
	(Part 1/Sec 3)	Concrete piles, Section 3 2010 Precast driven concrete piles (second revision)
	(Part 1/Sec 4)	Concrete piles, Section 4 2010 Precast concrete piles in prebored holes (first revision)
	(Part 2) : 1980	Timber piles (first revision)
	(Part 3) : 1980	Under-reamed piles (first revision)
	(Part 4) : 2013	Load test on piles (second revision)
14.1.4	IS 2974	Code of practice for design and construction of machine foundations
	(Part 1) : 1982	Foundations for reciprocating type machines (second revision)
	(Part 2) : 1980	Foundations for impact type machines (hammer foundations) (first revision)
	(Part 3) : 1992	Foundations for rotary type machines (medium and high frequency) (second revision)
	(Part 4) :1979	Foundations for rotary type machines of low frequency (first revision)
	(Part 5) :1987	Foundations for impact machines other than hammers forging and stamping press pig breakers (drop crusher and jolter) (first revision)
14.1.5	IS 9456 : 1980	Code of practice for design and construction of conical and hyperbolic paraboidal types of shell foundations
14.1.6	IS 9556 : 1980	Code of practice for design and construction of diaphragm walls
14.1.7	IS 12070 : 1987	Code of practice for design and construction of shallow foundations on rock
14.1.8	IS13094 : 1992	Guidelines for selection of ground improvement techniques for foundation in weak soils
14.1.9	IS14593 : 1998	Design and construction of bored cast-in-situ piles founded on rocks .
14.1.10	IS15284	Design and construction for ground improvement:
	(Part 1) : 2003	Stone columns
	(Part 2) : 2004	Pre-consolidation using vertical drains

14.2 Masonry

14.2.1	IS 1597	Code of practice for construction of stone masonry
	(Part 1) : 1992	Rubble stone masonry (first revision)
	(Part 2) : 1992	Ashlar masonry (first revision)
14.2.2	IS 2110 : 1980	Code of practice for in-situ construction of walls in buildings with soil-cement (first revision)
14.2.3	IS 2212 : 1991	Code of practice for bric kwork (first revision)
14.2.4	IS 2250 : 1981	Code of practice for preparation and use of masonry mortars (first revision)
14.2.5	IS 2572 : 2005	Code of practice for construction of hollow and solid concrete block masonry (first revision)
14.2.6	IS 3630 : 1992	Code of practice for construction of non-load bearing gypsum block partitions (first revision)
14.2.7	IS 4407 : 1967	Code of practice for reed walling
14.2.8	IS 4441 : 1980	Code of practice for use of silicate type chemical resistant mortars (first revision)
14.2.9	IS 4442 : 1980	Code of practice for use of sulphur type chemical resistant mortars (first revision)
14.2.10	IS 4443 : 1980	Code of practice for use of resin type chemical resistant mortars (first revision)
14.2.11	IS 6041 : 1985	Code of practice for construction of autoclaved cellular concrete block masonary (first revision)
14.2.12	IS 6042 : 1969	Code of practice for construction of light weight concrete block masonry (first revision)

14.3 Timber and Bamboo

14.3.1	IS 1634 : 1992	Code of practice for design and constructions of wood stair for houses (second revision)
14.3.2	IS 2366 : 1983	Code of practice for nail-jointed timber construction (first revision)
14.3.3	IS 3670 : 1989	Code of practice for construction of timber floors (first revision)
14.3.4	IS 4913 : 1968	Code of practice for selection, installation and maintenance of timber doors and windows
14.3.5	IS 4983 : 1968	Code of practice for design and construction of nail laminated timber beams
14.3.6	IS 5390 : 1984	Code of practice for construction of timber ceilings (first revision)
14.3.7	IS 11096 : 1984	Code of practice for design and construction of bolt-jointed timber construction

14.3.8	IS 12506 : 1988	Code of practice for improved thatching of roof with wrought and fire retardant treatment

14.4 Concrete

14.4.1	IS 456 : 2000	Code of practice for plain and reinforced concrete (fourth revision)
14.4.2	IS 457 : 1957	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures
14.4.3	IS 1343 : 2012	Code of practice for pre-stressed concrete (second revision)
14.4.4	IS 2502 : 1963	Code of practice for bendi ng and fixing of bars for concrete reinforcement
14.4.5	IS 2541 : 1991	Code of practice for preparation and use of lime concrete (second revision)
14.4.6	IS 3370	Code of practice for concrete structures for the storage of liquids:
	(Part 1) : 2009	General requirements (first revision)
	(Part 2) : 2009	Reinforced concrete structures (first revision)
	(Part 3) :1967	Prestressed Concrete Structures
14.4.7	IS 3558 : 1983	Code of practice for use of immersion vibrators for consolidating concrete (first revision)
14.4.8	IS 4926 : 2003	Code of practice for ready- mixed concrete (second revision)
14.4.9	IS 5817 : 1992	Code of practice for preparation and use of lime pozzolana mixture concrete in buildings and roads (first revision)
14.4.10	IS 7246 : 1974	Recommendations for use of table vibrators for consolidating concrete
14.4.11	IS 7861	Code of practice for extreme whether concreting:
	(Part 1) : 1975	Recommended practice for hot weather concreting
	(Part 2) : 1981	Recommended practice for cold weather concreting
14.4.12	IS 10262 : 2009	Guidelines for concrete mix design proportioning (first revision)
14.4.13	IS 10359 : 1982	Code of practice for manufacture and use of lime pozzolana concrete blocks for paving
14.4.14	IS 14687 : 1999	Guidelines for falsework for concrete structures

14.5 IS Steel

14.5.1	IS 800 : 2007	Code of practice for general construction in steel (third revision)
14.5.2	IS 801 : 1975	Code of practice for use of cold formed light gauge steel structural members in general building construction

		(first revision)
14.5.3	IS 805 : 1968	Code of practice for use of steel in gravity water tanks
14.5.4	IS 806 : 1968	Code of practice for use ofsteel tubes in general building construction (first revision)
14.5.5	IS 4000 : 1992	Code of practice for high strength bolts in steel structures (first revision)
14.5.6	IS 4180 : 1967	Code of practice for corrosion protection of light gauge steel sections used in building
14.5.7	IS 6533	Code of practice for design and construction of steelchimneys:
	(Part 1) : 1989	Mechanical aspects (first revision)
	(Part 2) : 1989	Structural aspects (first revision)
14.5.8	IS 8629 (Parts 1 to 3)	Code of practice for 977 protection of iron and steel structures from atmospheric corrosion
14.5.9	IS 9077 : 1979	Code of practice of corrosion protection of steel reinforcement in RB and RCC construction
14.5.10	IS 9172 : 1979	Recommended design practice for corrosion prevention of steel structures

14.6 Flooring and Roofing

14.6.1	IS 658 : 1982	Code of practice for magnesium oxychloride composition floors (second revision)
14.6.2	IS 1196 : 1978	Code of practice for laying bitumen mastic flooring (second revision)
14.6.3	IS 1197 : 1970	Code of practice for laying of rubber floors (first revision)
14.6.4	IS 1198 : 1982	Code of practice for laying, fixing and maintenance of linoleum floor (first revision)
14.6.5	IS 1443 : 1972	Code of practice for laying and finishing of cement concrete flooring tiles (first revision)
14.6.6	IS 2118 : 1980	Code of practice for construction of jack-arch type of building floor or roof (first revision)
14.6.7	IS 2119 : 1980	Code of practice for construction of brick-cum-concrete composite (Madras terrace) floor or roof (first revision)
14.6.8	IS 2204 : 1962	Code of practice for construction of reinforced concrete shell roof
14.6.9	IS 2571 : 1970	Code of practice for laying in-situ cement concrete flooring (first revision)

14.6.10	IS 2700 : 1987	Code of practice for roofing with wooden shingles (first revision)
14.6.11	IS 2792 : 1964	Code of practice for design and construction of stone slab over joist floor
14.6.12	IS 2858 : 1984	Code of practice for roofing with Mangalore tiles (first revision)
14.6.13	IS 3007	Code of practice for laying of asbestos cement sheets
	(Part 1) : 1999	Corrugated sheets (first revision)
	(Part 2) : 1999	Semi-corrugated sheets (first revision)
14.6.14	IS 3670 : 1989	Code of practice for construction of timber floors (first revision)
14.6.15	IS 5119	Code of practice for laying and fixing of sloped roof coverings
	(Part 1) : 1968	Slating
14.6.16	IS 5318 : 1969	Code of practice for laying of flexible PVC sheet and tile flooring
14.6.17	IS 5389 : 1969	Code of practice for laying of hard wood parquet and wood block floors
14.6.18	IS 5390 : 1984	Code of practice for construction of timber ceilings (first revision)
14.6.19	IS 5766 : 1970	Code of practice for laying burnt clay brick flooring
14.6.20	IS 6061	Code of practice for construction of floor and roof with joists and filler blocks
	(Part 1) : 1971	With hollow concrete filler blocks
	(Part 2) : 1981	With hollow clay filler blocks (first revision)
	(Part 3) : 1981	Precast hollow clay blocks joists and hollow clay filler blocks
	(Part 4) : 1981	With precast hollow clay block slab panels
14.6.21	IS 6332 : 1984	Code of practice for construction of floors and roofs using precast doubly-curved shell units (first revision)
14.6.22	IS 9472 : 1980	Code of practice for laying mosaic parquet flooring
14.6.23	IS 10297 : 1982	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units
14.6.24	IS 10440 : 1983	Code of practice for construction of reinforced brick and RBC floors and roofs
14.6.25	IS 10505 : 1983	Code of practice for construction of floors and roofs using precast concrete waffle units

14.7 Finishes

14.7.1	IS 1346 : 1991	Code of practice for waterproofing of roofs with bitumen felts (third revision)
14.7.2	IS 1414 : 1989	Code of practice for fixing wall coverings
14.7.3	IS 1477	Code of practice for painting of ferrous metals in buildings
	(Part 1) : 1971	Pretreatment (first revision)
	(Part 2) : 1971	Painting (first revision)
14.7.4	IS 1609 : 1991	Code of practice for laying damp-proofing treatment using bitumen felts (second revision)
14.7.5	IS 1661 : 1972	Code of practice for application of cement and cement lime plaster finishes (first revision)
14.7.6	IS 2114 : 1984	Code of practice for laying in-situ terrazzo floor finish (first revision)
14.7.7	IS 2115 : 1980	Code of practice for flat-roof finish : Mud Phuska (second revision)
14.7.8	IS 2338	Code of practice for finishing of wood and wood based materials
	(Part 1) : 1967	Operations and workmanship
	(Part 2) : 1967	Schedules
14.7.9	IS 2394 : 1984	Code of practice for application of lime plaster finish (first revision)
14.7.10	IS 2395	Code of practice for painting concrete, masonry and plaster surfaces
	(Part 1) : 1994	Operations and workmanship (first revision)
	(Part 2) : 1994	Schedule (first revision)
14.7.11	IS 2402 : 1963	Code of practice for external rendered finishes
14.7.12	IS 2441 : 1984	Code of practice for fixing ceiling covering (first revision)
14.7.13	IS 2524	Code of practice for painting of non-ferrous metals in buildings
	(Part 1) : 1968	Pre-treatment
	(Part 2) : 1968	Painting
14.7.14	IS 3036 : 1992	Code of practice for laying lime concrete for a water-proofed roof finish (second revision)
14.7.15	IS 3067 : 1988	Code of practice for general design details and preparatory work for damp- proofing and waterproofing of buildings (first revision)

14.7.16	IS 3140 : 1965	Code of practice for painting asbestos cement building products
14.7.17	IS 4101	Code of practice for external facing and veneers
	(Part 1) : 1967	Stone facing
	(Part 2) : 1967	Cement concrete facing
	(Part 3) : 1985	Wall tiling and mosaics (first revision)
14.7.18	IS 4365 : 1967	Code of practice for application of bitumen mastic for waterproofing of roofs
14.7.19	IS 4597 : 1968	Code of practice for finishing of wood and wood based products with nitrocellulose and cold catalysed materials
14.7.20	IS 4631 : 1986	Code of practice for laying of epoxy resin floor toppings (first revision)
14.7.21	IS 5491 : 1969	Code of practice for laying in- situ granolithic concrete floor topping
14.7.22	IS 6278 : 1971	Code of practice for white washing and colour washing
14.7.23	IS 6494 : 1988	Code of practice for waterproofing of underground water reservoirs and swimming pools (first revision)
14.7.24	IS 7198 : 1974	Code of practice for damp- proofing using bitumen mastic
14.7.25	IS 7290 : 1979	Recommendations for use of polyethylene film for waterproofing of roofs (first revision)
14.7.26	IS 9918 : 1981	Code of practice for in-situ waterproofing and damp-proofing treatments with glass fibre tissue reinforcedbitumen
14.7.27	IS 10439 : 1983	Code of practice for patent glazing
14.7.28	IS 16135 : 2014	Code of practice for dry lining and partitioning using gypsum plasterboards
14.7.29	IS 16231	Code of practice of use of glass in buildings
	(Part 1) : 2016	General methodology and selection
	(Part 2) : 2016	Energy and light
	(Part 3) : 2016	Fire and loading
	(Part 4) : 2014	Safety related to human Impact

14.8 Piping

14.8.1	IS 783 : 1985	Code of practice for laying of concrete pipes (first revision)
14.8.2	IS 3114 : 1994	Code of practice for laying of cast iron pipes (second revision)
14.8.3	IS 4127 : 1983	Code of practice for laying of glazed stoneware pipes (first revision)

14.8.4	IS 5329 : 1983	Code of practice for sanitary pipe work above ground forbuildings (first revision)
14.8.5	IS 5822 : 1994	Code of practice for laying of welded steel pipes for water supply (second revision)
14.8.6	IS 6530 : 1972	Code of practice for laying of asbestos cement pressure pipes
14.8.7	IS 7634	Code of practice for plastics pipe work for portable water supplies
	(Part 1) : 1975	Choice of materials and general recommendations
	(Part 2) : 2012	Laying and jointing polyethylene (PE) pipes (first revision)
	(Part 3) : 2003	Laying and jointing of unplasticized PVC pipes
14.8.8	IS 13916 : 1994	Code of practice for installation of glass fibre reinforced plastic piping system

14.9 Measurements

14.9.1	IS 1200	Method of measurement of building and civil engineering works
	(Part 1) : 1992	Earthwork (fourth revision)
	(Part 2) : 1974	Concrete work (third revision)
	(Part 3) : 1976	Brickwork (third revision)
	(Part 4) :1976	Stone masonry (third revision)
	(Part 5) : 2013	Formwork (fourth revision)
	(Part 6) : 1974	Refactory work (second revision)
	(Part 7) : 2013	Hardware (third revision)
	(Part 8) : 1993	Steel work and iron work (fourth revision)
	(Part 9) : 1973	Roof covering (including cladding) (second revision)
	(Part 10) : 2013	Ceiling and linings (thirdrevision)
	(Part 11) : 2013	Paving, floor finishes dado and skirting (fourth revision)
	(Part 12) : 1976	Plastering and pointing (third revision)
	(Part 13) : 1994	White washing, colour washing, distempering and painting of building surfaces (fifth revision)
	(Part 14) : 1984	Glazing (third revision)
	(Part 15) : 1987	Paining, polishing,varnishing, etc (fourth revision)
	(Part 16) : 1979	Laying of water and sewer lines including appurtenant items (third revision)
	(Part 17) : 1985	Roadwork including air field pavements (third revision)
	(Part 18) : 1974	Demolition and dis-mantling (third revision)
	(Part 19) : 1981	Water supply, plumbing and drains (third revision)

	(Part 20) : 1981	Laying of gas and oil pipe lines (third revision)
	(Part 21) : 1973	Woodwork and joinery (second revision)
	(Part 23) : 1988	Piling (fourth revision)
	(Part 24) : 1983	Well foundations (third revision)
	(Part 27) : 2013	Earth work done by mechanical appliances
14.9.2	IS 3861 : 2002	Method of measurement of plinth, carpet and rentable areas of buildings (second revision)

14.10 Others

14.10.1	IS 1081 : 1960	Code of practice for fixing and glazing of metal (steel and aluminium) doors,windows and ventilators
14.10.2	IS 1649 : 1962	Code of practice for design and construction of flues and chimneys for domestic heating appliances
14.10.3	IS 1946 : 1961	Code of practice for use of fixing devices in walls, ceilings and floors of solid construction
14.10.4	IS 2470	Code of practice for installation of septic tanks
	(Part 1) : 1985	Design criteria and construction (second revision)
	(Part 2) : 1985	Secondary treatment and disposal of septic tank effluent (second revision)
14.10.5	IS 2527 : 1984	Code of practice for fixing rain-water gutters and down pipes for roof drainage (first revision)
14.10.6	IS 3414 : 1968	Code of practice for design and installation of joints in buildings
14.10.7	IS 3548 : 1988	Code of practice for glazing in buildings (first revision)
14.10.8	IS 3558 : 1983	Code of practice for use of immersion vibrators for consolidating concrete (first revision)
14.10.9	IS 4326 : 2013	Code of practice for earthquake resistant design and construction of buildings (third revision)
14.10.10	IS 3935 : 1966	Code of practice for composite construction
14.10.11	IS 4913 : 1968	Code of practice for selection, installation and maintenance of timber doors and windows
14.10.12	IS 6313	Code of practice for anti-termite measures in buildings
	(Part 1) : 1981	Constructional measures (first revision)
	(Part 2) : 2013	Pre – constructional chemical treatment measures (third revision)
	(Part 3) : 2013	Treatment for existing buildings (third revision)
14.10.13	IS 6924 : 1973	Code of practice for the construction of refuse chutes in multistoreyed buildings

14.10.14	IS 7246 : 1974	Recommendation for use of table vibrators for consolidating concrete
14.10.15	IS 8147 : 1976	Code of practice for use of aluminium alloys in structures
14.10.16	IS 15345 : 2003	Code of practice for installation of frameless door and window shutters
14.10.17	IS 15916 : 2010	Code of practice for building design and erection using prefabricated concrete
14.10.18	IS 15917 : 2010	Code of practice for building design and erection using mixed/ composite construction

[7(15)]

15.1	IS 2750 : 1964	Specification for steel scaffoldings
15.2	IS 14687 : 1999	Guidelines for falsework for concrete structures
15.3	IS 3696 (Part 1):1987	Safety code for scaffolds and ladders: Part 1 Scaffolds
15.4	IS 4014	Code of practice for steel tubular scaffolding
	(Part 1) : 1967	Definitions and materials
	(Part 2) : 2013	Safety regulations for scaffolding (first revision)

[7(16)]	IS 6521(Part 1):1972	Code of practice for design of tower cranes Part 1 Static and rail mounted
[7(17)]	IS 13558 (Part 3)	Cranes control layout 1995 and characteristics: Part 3 Tower cranes
[7(18)]	IS 14687 : 1999	Guidelines for falsework for concrete structures
[7(19)]	IS 3764 : 1992	Safety code for excavation work (first revision)
[7(20)]	IS 13416 (Part 5)	Recommendations for 1994 preventive measure against hazards at workplaces :Part 5 Fire protection
	& MNFC (2020)	Myanmar Fire Safety Code (2020)

[7(21)]

21.1	IS 15683 : 2006	Specification for portable fire extinguishers Performance and construction
21.2	IS 16018 : 2012	Specification for wheeled fire extinguishers Performance and construction

[7(22)]	SS 578 (MNFC 2020)	Code of practice for use and maintenance of Portable fire extinguishers.(Also refer to code & Standard)
[7(23)]	IS 8758 : 2013	Code of practice for fire precautionary measures in construction of temporary structures and pandals (second revision)

[7(24)]

24.1	IS 10439 : 1983	Code of practice patent glazing
24.2	IS 14687 : 1999	Guidelines for falsework for concrete structures

[7(25)]		IS 4138 : 1977	Safety code for working in compressed air (first revision)
[7(26)]		IS 2925 : 1984	Specification for industrial safety helmets (second revision)
[7(27)]		IS 2750 : 1964	Specification for steel Scaffoldings
[7(28)]			
	28.1	IS 3696 (Part 1):1987	Safety code for scaffolds and ladders: Part 1 Scaffolds
	28.2	IS 4014 (Part 2):2013	Code of practice for steel tubular scaffolding: Part 2 Safety provisions for scaffolding (first revision)
[7(29)]		IS 3696 (Part 2):1991	Safety code for scaffolds and ladders: Part 2 Ladders
[7(30)]		IS 4912 : 1978	Safety requirements for floors and wall openings, railing and toe boards (first revision)
[7(31)]		IS 5983 : 1980	Specification for eye- protectors (first revision)
[7(32)]		IS 1179 : 1967	Specification for equipment for eye and face protection during welding (first revision)
[7(33)]		IS 2361 : 2002	Specification for bull-dog grips (third revision)
[7(34)]		IS 11057 : 1984	Specification for industrial safety nets
[7(35)]		IS 3016 : 1982	Code of practice for fire precautions in welding and cutting operations (first revision)
[7(36)]			
	36.1	IS 1084 : 2005	Specification for manila ropes (fifth revision)
	36.2	IS 2266 : 2002	Specification for steel wire ropes for general engineering purposes (fourth revision)
[7(37)]		IS 818 : 1968	Code of practice for safety and health requirements in electric and gas welding and cutting operations (first revision)
[7(38)]		IS 13416 (Part 4) : 1994	Recommendations for preventive measure against hazards at workplaces : Part 4 Timber structure
[7(39)]		IS 15683 : 2006	Portable fire extinguishers . Performance and construction . Specification
[7(40)]			
	40.1	IS 819 : 1957	Code of practice for resistance spot welding for light assemblies in mild steel
	40.2	IS 1261 : 1959	Code of practice for seam welding in mild steel
	40.3	IS 3016 : 1982	Code of practice for fire precautions in welding and cutting operations (first revision)
	40.4	IS 4081 : 2013	Blasting and related drilling operations Code of Safety (second revision)
	40.5	IS 4138 : 1977	Safety code for working in compressed gas (first revision)

	40.6	IS 9595 : 1996	Recommendations for metal arc welding of carbon and carbon manganese steels (first revision)
	40.7	IS 10178 : 1995	Recommended procedure for CO2 gas shielded metal-arc welding of structural steels (first revision)
[7(41)]			
	41.1	SS 575, BS 6391	Code of practice for fire hydrants, rising mains and hose systems and the Standard for specification of non-percolating layflat delivery hoses and hose assemblies for fighting purposes
	41.2	BS 5041-1:1987	Specification for fire hydrants system equipment
		BS 336	BS standard instantaneous couplings
[7(42)]		IS 13416 (Part 2)	Recommendation for 1992 preventive measures against hazards at work places: Part 2 Fall prevention
[7(43)]		IS 13416 (Part 1)	Recommendation for1992 preventive measures against hazards at work places:Part 1 Falling material hazard prevention
[7(44)]		IS 13416 (Part 3)	Recommendation for 1994 preventive measures against hazards at work places:Part 3 Disposal of debris
[7(45)]		IS 274	Specification for shovels
	45.1	IS (Part 1) : 1981	General purpose shovels(third revision)
	45.2	IS (Part 2) : 1981	Heat-treated shovels (third revision)
	45.3	IS 663 : 1980	Specification for adzes (second revision)
	45.4	IS 704 : 1984	Specification for crow bars and claw bars (second revision)
	45.5	IS 841 : 1983	Specification for steel hammers (second revision)
	45.6	IS 844	Specification for screw drivers
		(Part 2) : 1979	Dimensions(second revision)
		(Part 3) : 1979	Dimensions for screw drivers for recessed headscrew (second revision)
	45.7	IS 1630 : 1984	Specification for Mason’s tools for plaster work an pointing work (first revision)
	45.8	IS 1759 : 1986	Specification for Powrahs (second revision)
	45.9	IS 1791 : 1985	Specification for batch type concrete mixers (second revision)
	45.10	IS 1930 : 2003	Woodworking tools .Chisels and gouges (third revision)
	45.11	IS 1931 : 2000	Specification for engineer’s files (third revision)
	45.12	IS 2028 : 2004	Specification for open jaw wrenches (spanners) (fourth revision)

45.13	IS 2029 : 1998	Specification for ring wrenches (spanners) (fourth revision)
45.14	IS 2030 : 1989	Specification for box spanners (second revision)
45.15	IS 2094	Specification for heater for bitumen (tar) and emulsion (second revision)
	(Part 1) : 1996	Specification (second revision)
	(Part 2) : 1999	Bitumen sprayer (third revision)
	(Part 3) : 1999	Emulsion (third revision)
45.16	IS 2431 : 1963	Specification for steel wheel barrows (single wheel-type)
45.17	IS 2438 : 1963	Specification for roller pan Mixer
45.18	IS 2505 : 1992	Specification for concrete vibrators, immersion type General requirements (third revision)
45.19	IS 2506 : 1985	General requirements for screed board concrete vibrators (first revision)
45.20	IS 2514 : 1963	Specification for concrete vibrating tables
45.21	IS 2587 : 1975	Specification for pipes vices (open side type and fixed sides type) (first revision)
45.22	IS 2588 : 1975	Specification for black- smith.s vices (first revision)
45.23	IS 2722 : 1964	Specification for portableswing weigh batchers for concrete (single and double bucket type)
45.24	IS 2852 : 1998	Specification for carpenters augers (first revision)
45.25	IS 3066 : 1965	Specification for hot asphalt mixing plants
45.26	IS 3251 : 1965	Specification for asphalt paver finisher
45.27	IS 3365 : 1965	Specification for floor polishing machines
45.28	IS 3559 : 1966	Specification for pneumatic concrete breakers
45.29	IS 3587 : 1986	Specification for rasps (second revision)
45.30	IS 3650 : 1981	Specification for combination side cutting pliers (second revision)
45.31	IS 3938 : 1983	Specification for electric wire rope hoists (second revision)
45.32	IS 4003	Specification for pipe wrenches
	(Part 1) : 1978	General purposes (first revision)
	(Part 2) :1986	Heavy duty (first revision)
45.33	IS 4017 : 1992	Specification for carpenters squares (first revision)
45.34	IS 4095 : 1991	Specification for pincers (second revision)

45.35	IS 4183 : 1967	Specification for metal hand rammers
45.36	IS 4184 : 1967	Specification for steel wheel barrows (with two wheels)
45.37	IS 4508 : 1992	Specification for open ended slugging wrenches (spanners) (first revision)
45.38	IS 4915 : 1968	Specification for welders chipping hammer
45.39	IS 5066 : 1969	Specification for glass pliers
45.40	IS 5067 : 1969	Specification for fencing pliers
45.41	IS 5087 : 1969	Specification for wire stripping pliers
45.42	IS 5098 : 1969	Specification for cross cut and rip saws
45.43	IS 5123 : 1969	Specification for tenon and dovetail saws
45.44	IS 5169 : 1986	Specification for hack-saw frames (first revision)
45.45	IS 5200 : 1998	Specification for bolt clippers (first revision)
45.46	IS 5658 : 1990	Specification for snipenose pliers (first revision)
45.47	IS 5663 : 1970	Specification for brick and mason.s chisels
45.48	IS 5684 : 1970	Specification for pipe vices (chain type)
45.49	IS 5697 : 1970	Specification for ripping chisels
45.50	IS 5889 : 1994	Specification for vibratory plate compactor (first revision)
45.51	IS 5890 : 2004	Mobile hot mix asphalt plants,light duty Requirements (first revision)
45.52	IS 5891 : 1970	Specification for hand- operated concrete mixer
45.53	IS 5995 : 1971	Specification for pipe grip pliers
45.54	IS 6007 : 1971	Specification for pipe vices (hinged type)
45.55	IS 6078 : 1986	Specification for Lineman’s pliers (second revision)
45.56	IS 6087 : 1971	Specification for metal cutting shears
45.57	IS 6118 : 1991	Specification for multiple slip joint pliers (first revision)
45.58	IS 6149 : 1984	Specification for single ended open jaw adjustable wrenches (first revision)
45.59	IS 6375 : 1991	Specification for wood splitting wedges (first revision)
45.60	IS 6389 : 1998	Specification for combination wrenches with equal openings (second revision)
45.61	IS 6428 : 1972	Specification for pile frame
45.62	IS 6430 : 1985	Specification for mobile aircompressor for construction purposes (first revision)
45.63	IS 6433 : 1972	Specification for guniting equipment
45.64	IS 6546 : 1989	Specification for claw hammers (first revision)

45.65	IS 6836 : 1973	Specification for hand snaps and set-ups for solid rivets
45.66	IS 6837 : 1973	Specification for three wheel type pipe cutter
45.67	IS 6841 : 1973	Specification for wrecking bars
45.68	IS 6861 : 1973	Specification for engineers.scrapers
45.69	IS 6881 : 1973	Specification for link type pipe cutters
45.70	IS 6891 : 1973	Specification for carpenter.s auger bits
45.71	IS 6892 : 1973	Specification for black-smith.s brick-iron
45.72	IS 7041 : 1973	Specification for carpenter's plain brace
45.73	IS 7042 : 1973	Specification for carpente's ratchet brace
45.74	IS 7077 : 1973	Specification for bending bars
45.75	IS 7958 : 1976	Specification for hand vices
45.76	IS 8202 : 1999	Specification for carpenter's wooden bodied planes (first revision)
45.77	IS 8671 : 1977	Specification for nail puller
[7(46)]	IS 7293 : 1974	Safety code for working with construction machinery
[7(47)]	IS 4130 : 1991	Safety code for demolition of buildings (second revision)
[7(48)]	IS 13367: 1992	Safe use of cranes
	IS 13583: 1993	
	Part 1	:Cranes- Training of drivers, general (crane lifting changes and related equipments)
[7(49)]	IS 15183(Part3):2002	Maintenance management for buildings Guidelines:Part3 Labour
[7(50)]	IS 15183(Part2):2002	Maintenance management for buildings _ Guidelines:Part2 Finance

MNBC -2025 TECHNICAL WORKING GROUP (TWG-7)

Participants List

1. U Aung Myint	Group Leader
2. U Kyi Lwin	Deputy Group Leader
3. U Win Tint	Member
4. U Kyi Soe	Member
5. U Aung Koe	Member
6. U Saw Htun Hla Baw	Member
7. Daw Aye Aye Khine	Member
8. Daw Po Po Min	Member
9. U Htay Oo	Member
10. U Yin Htwe Thet	Member
11. U Myint Oo	Member
12. Daw Mya Win	Member
13. Daw Thandar Win	Member
14. Daw Khine Nyein Soe	Member
15. Daw Mya Myet Chel	Member
16. U Min Min	Member
17. Daw Wint Moh Aung	Member
18. U Htein Linn Aung	Member
19. Daw Ei Win Khine	Member
20. Dr.Daw Khin Su Su Htwe	Member
21. U Htin Aung	Member
22. U Khin Mg Win	Member
23. Daw Su Ya Ta Nar Tun	Member
24. Daw Pann Ei Swe	Member
25. U Myint Sein	Member

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PART 6 & PART 7