भारतीय मानक ब्यूरो
(उपभोक्ता मामले, खाद्य एवं सार्वजनिक वितरण मंत्रालय, भारत सरकार)
BUREAU OF INDIAN STANDARDS
(Ministry of Consumer Affairs, Food & Public Distribution, Govt. of India)

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व्यापक परिचालन मसौदा

हमारा संदर्भ: सीईडी 46 /टी-13 **08 मार्च 2025**

तकनीकी समिति: भारत की राष्ट्रीय भवन निर्माण विषय समिति, सीईडी 46

प्राप्तकर्ता :

1. **सिविल अभियांत्रिकी विभाग परिषद, सीईडीसी के सभी सदस्य**
2. **राष्ट्रीय भवन निर्माण संहिता विषय समिति, सीईडी 46 के सभी सदस्य**
3. **सीईडी 46 की उपसीमितयों और अन्य कार्यदल के सभी सदस्य**
4. **रुचि रखने वाले अन्य निकाय।**

महोदय/महोदया,

निम्नलिखित मानक का मसौदा संलग्न हैं:

प्रलेख संख्या	शीर्षक
सीईडी 46 (26876) WC	**भारत की राष्ट्रीय भवन निर्माण संहिता - भाग 7 भवन निर्माण प्रबंधन, रीतियाँ तथा सुरक्षा** [SP7(भाग 7) का चौथा पुनरीक्षण] (आई सी एस नंबर: 01.120: 91.040.01)

कृपया इस मसौदे का अवलोकन करें और अपनी सम्मतियाँ यह बताते हुए भेजे कि यह मसौदा प्रकाशित हो तो इस पर अमल करने में आपको व्यवसाय अथवा कारोबार में क्या कठिनाइयां आ सकती हैं।

सम्मतियाँ भेजने की अंतिम तिथि: 06 अप्रैल 2025

सम्मति यदि कोई हो तो कृपया अधोहस्ताक्षरी को ई-मेल द्वारा ced46@bis.gov.in पर या उपरलिखित पते पर, संलग्न फोर्मेट में भेजें। सम्मतियाँ बीआईएस ई-गवर्नेंस पोर्टल, www.manakonline.in के माध्यम से ऑनलाइन भी भेजी जा सकती हैं।

यदि कोई सम्मति प्राप्त नहीं होती है अथवा सम्मति में केवल भाषा संबंधी त्रुटि हुई तो उपरोक्त प्रलेख को यथावत अंतिम रूप दे दिया जाएगा। यदि सम्मति तकनीकी प्रकृति की हुई तो विषय समिति के अध्यक्ष के परामर्श से अथवा उनकी इच्छा पर आगे की कार्यवाही के लिए विषय समिति को भेजे जाने के बाद प्रलेख को अंतिम रूप दे दिया जाएगा।

यह प्रलेख भारतीय मानक ब्यूरो की वैबसाइट www.bis.gov.in पर भी उपलब्ध हैं।
धन्यवाद।

भवदीय

ह/-
(द्वैपायन भद्र)
वैज्ञानिक 'ई' एवं प्रमुख (सिविल अभियांत्रिकी विभाग)

सलंग्न: उपरिलिखि

भारतीय मानक ब्यूरो
(उपभोक्ता मामले, खाद्य एवं सार्वजनिक वितरण मंत्रालय, भारत सरकार)
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Website: www.bis.org.in , www.bis.gov.in

WIDE CIRCULATION DRAFT

Our Reference: CED 46/T-13 **08 March 2025**

National Building Code of India Sectional Committee, CED 46

ADDRESSED TO:

1. All Members of Civil Engineering Division Council, CEDC
2. All Members of the National Building Code Sectional Committee, CED 46
3. All Members of Subcommittees, Panels and Working Groups under CED 46
4. All others interested

Dear Sir/Madam,

Please find enclosed the following draft:

Doc No.	Title
CED 46 (26876) WC	**National Building Code of India Part 7 - Construction Management, Practices and Safety** [Fourth Revision of SP 7 (Part 7)] (ICS No. 01.120: 91.040.01)

Kindly examine the attached draft and forward your views stating any difficulties which you are likely to experience in your business or profession, if this is finally adopted as National Standard.

Last Date for comments: 06 April 2025

Comments if any, may please be made in the enclosed format and emailed at ced46@bis.gov.in or sent at the above address. Additionally, comments may be sent online through the BIS e-governance portal, www.manakonline.in.

In case no comments are received or comments received are of editorial nature, kindly permit us to presume your approval for the above document as finalized. However, in case comments, technical in nature are received, then it may be finalized either in consultation with the Chairman, Sectional Committee or referred to the Sectional Committee for further necessary action if so desired by the Chairman, Sectional Committee.

The document is also hosted on BIS website www.bis.gov.in.

Thanking you,

Yours faithfully,

Sd/-
(Dwaipayan Bhadra)
Scientist 'E' / Director and Head
(Civil Engineering Department)

Encl: As above

FORMAT FOR SENDING COMMENTS ON THE DOCUMENT

[Please use A4 size sheet of paper only and type within fields indicated. Comments on each clause/sub-clause/ table/figure, etc, be stated on a fresh row. Information/comments should include reasons for comments, technical references and suggestions for modified wordings of the clause. **Comments through e-mail to ced46@bis.gov.in shall be appreciated**.

Doc. No.: CED 46 (26876) WC **BIS Letter Ref**: CED 46/T-13

Title: National Building Code of India - Part 7 Construction Management, Practices and Safety [Fourth Revision of SP 7 (Part 7)] (ICS No.01.120:91.040.01)

Last date of comments: **06 April 2025**

Name of the Commentator/ Organization: _____

Clause/ Para/ Table/ Figure No. commented	Comments/Modified Wordings	Justification of Proposed Change

NOTE- Kindly insert more rows as necessary for each clause/table, etc

BUREAU OF INDIAN STANDARDS

DRAFT FOR COMMENTS ONLY

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Draft **National Building Code of India**

PART 7 CONSTRUCTION MANAGEMENT, PRACTICES AND SAFETY

[Fourth Revision of SP 7 (Part 7)]

(ICS No. 01.120: 91.040.01)

National Building Code Sectional Committee, CED 46	**Last Date for Comments: 06 April 2025**

C O N T E N T S

15 ~~REPAIRS AND~~ SEISMIC STRENGTHENING AND RETROFITTING OF BUILDINGS

The provisions of this clause will be suitably updated with the revised IS 13935, *Seismic Evaluation, Repair, and Strengthening of Masonry Buildings – Buildings – Doc: CED 39(26742)WC*.

SECTION 6 HABITAT AND WELFARE REQUIREMENTS FOR WORKERS

16 HABITAT AND OTHER WELFARE REQUIREMENTS FOR CONSTRUCTION WORKERS

ANNEX A CHECK LIST FOR STACKING AND STORAGE OF MATERIALS

ANNEX B C&D WASTE MANAGEMENT PLAN

ANNEX C C&D WASTE REUSE POTENTIAL

ANNEX D RECORD OF C&D WASTE DETAILS

ANNEX E LIST OF DEMOLITION METHODOLOGIES

ANNEX F GENERAL CHECKLIST

ANNEX G SAFETY SIGNAGES

ANNEX H GENERIC NAMES FOR BIM SOFTWARE CAPABILITY

ANNEX J BIM AND DIGITALIZATION ROLES

ANNEX K HARDWARE AND EQUIPMENT IN BIM IMPLEMENTATION

ANNEX M IMPACTS AND BENEFITS OF GENERATING AND USING BIM

LIST OF STANDARDS

National Building Code Sectional Committee, CED 46

FOREWORD

This Code (Part 7) covers construction project management; construction planning, site management and building construction practices; storage, stacking and handling of materials; and safety of personnel during construction operations for all elements of a building and demolition of buildings; and habitat and welfare requirements for workers. It also covers guidelines relating to repairs, retrofitting and strengthening of buildings.

The principles enunciated in the various sections of this Part are to be ultimately utilized and implemented in the physical construction of the buildings with the required infrastructure. This would require sound construction practices and efficient management thereof in order to ensure that the implementation of the project is carried out within the estimated cost and planned period to the required quality standards and in a safe and sustainable manner. Workers in large number, both skilled and unskilled, are engaged in the innumerable construction works. Due to increased tempo of such a building activity and large scale mechanization, hazards of accidents could increase considerably. It is, therefore, imperative that adequate safety rules are laid down for every phase of construction work. It is also important to give due cognizance to habitat and welfare requirements of workers at construction site. This Part also deals with these aspects.

Planning the various construction operations before hand and making adequate arrangements for procurement and storage of materials, and the machinery to get work done is as important as carrying out these construction operations in accordance with good practice. Lack of planning or defective planning may result in avoidable delay in the completion of work and consequently increased hazards from the point of view of fire, health and structural soundness. This Part covers provisions in this regard.

A construction project is an endeavour undertaken by a project team on behalf of owner/client to create a built facility suited to the defined functional objectives. From inception to commissioning, the project goes through various distinct stages leading to progressive achievement of project objectives. Each stage involves specific inputs, processes (both technical and managerial) and deliverables. Typically, the life cycle of a project from commencement to completion involves the following stages:

a) *Project formulation and appraisal* – Inception, feasibility and strategic planning;
b) *Project development* – Project brief development, planning and design, finalization of proposals, procurement strategy, construction documentation including tender drawings, working drawings, specifications, cost estimates, bills of quantities, procurement documents;
c) *Planning for construction* – Sequencing of project components, planning tools, resource planning and time cost trade off;
d) *Tender action* – Open competitive bidding/pre-qualification of agencies, issue of tender documents, evaluation of bids, negotiation if required and award of work;
e) *Construction* – Execution, monitoring, control, work acceptance; and

f) *Commissioning and handing over* – Contractual closeout, financial closeout, defect liability commencement, facility handing over.

The distinct features of a construction project include the temporary nature of the organizations involved, the evolutionary process of project deliverables during project development stages and the unique output of the built facility. As a result of these features, unless there is efficient and effective project management, a construction project is faced with challenges of uncertainties leading to time over-runs, cost over-runs, changes in project parameters, loss of quality and inability to meet the functional objectives. While technical soundness of a proposal is an important aspect of a construction project, the management aspects, which involve techno-legal, financial and other issues, have also a significant role in the success of a project. Therefore, management functions and technical processes in a construction project need to be integrated towards achieving project objectives. Top management commitment plays an important role in harmoniously achieving these project objectives. In some of the public sector projects, it may be necessary to share relevant information with public at large through appropriate means. The overall management of a building construction project is very important to ensure that the objectives of such a project are achieved through scope management, procurement management, time management, cost management, quality management, risk management, communication management, human resources management, safety, health and environment management and integration management. This Part, therefore, gives guidelines on these areas.

The first version of this Part was formulated in 1970, which was subsequently revised in 1983, 2005 and 2016. In the first revision of 1983, information regarding handling operations that is unloading, stacking, lifting, loading and conveying of building materials, was also given along with the storage practices. Additional information regarding the use of ladders; safety requirements for floor and wall openings, railings and toe boards; piling and other deep foundations; constructions involving use of hot bituminous materials; and erection of structural steel work and concrete framed structures, etc, were included.

In the second revision of 2005, the Section 1 'Construction Practices' of this Part, had been revamped to include the planning and management aspects. Further, provisions on construction using bamboo were also incorporated. The other important modifications incorporated in the second revision included comprehensive updating of the provisions with regard to stacking and storage of building materials and components, which were comprehensively covered in line with the revised IS 4082 : 1996 ‘Recommendations on stacking and storage of construction materials and components at site (*second revision*)’; addition of provisions of safety requirements of hoists/lifts for worker during construction; incorporation of aspects like preventive measures such as falling material hazards prevention, fall prevention, disposal of debris, fire protection, etc, with regard to safety at work site; addition of provisions regarding safety management at work sites; addition of a new section on 'Maintenance management, repairs, retrofitting and strengthening of buildings’, covering aspects like maintenance management, prevention of cracks, and repairs and seismic strengthening of buildings; and updating of safety provisions with respect to demolition of buildings.

As a result of experience gained in implementation of 2005 version of this Part and feedback received as well as in view of formulation of new standards in the field of construction project management and construction practices and revision of some existing standards, including those on safety, a need to revise this Part was felt. The

2016 revision was, therefore, prepared to take care of these aspects; and the Part was divided into six sections as follows, under which all technical provisions relating to their subject areas, have been given:

Section 1 Construction Management
Section 2 Construction Planning and Site Management
Section 3 Construction Practices
Section 4 Safety in Construction (now renamed as 'Safety in Construction and Demolition')
Section 5 Repairs, Retrofitting and Strengthening of Buildings
Section 6 Habitat and Welfare Requirements for Workers

The significant changes that were incorporated in the 2016 revision included detailing the provisions on construction project management, including aspects such as project formulation and appraisal; updated provision on safety provisions concerning scaffolding, piling, deep foundations, blasting, drilling operations, and the use of hot bituminous materials in construction; introduction of a new clause addressing habitat and welfare requirements for construction workers, along with an additional clause on urban/city roads planning and construction; and another clause on temporary works was also included. Further, the provisions regarding construction using bamboo were shifted to Part 6 'Structural Design, Section 3B Bamboo', and a reference to the same was made to in this Part; maintenance management provisions were moved to Part 12 'Asset and Facility Management' of the Code and a reference to the same was given in this Part; and additionally, references to all concerned Indian Standards were updated.

The significant changes incorporated in this revision include:

a) The title of Section 4 has been revised as 'Safety in Construction and Demolition', providing a more comprehensive focus on both aspects.

b) A new clause 5 has been introduced concerning the use of building information modelling (BIM) in construction projects, enhancing the integration of digital design and construction processes.

c) A new clause 6 on the permit to work system has been added, ensuring stricter control over high-risk activities at construction sites.

d) The provisions related to the demolition of buildings have been updated, in **12.**

e) Provisions have been introduced in **8.12** regarding the transportation and erection of precast and prefabricated elements during construction.

f) Provisions regarding the barricading of construction sites, shoring of excavated soil, and the monitoring of adjacent buildings located along the excavation line have been updated, ensuring improved safety and minimizing risks to surrounding structures.

g) The roles and responsibilities of the construction management team and the supervisory team have been defined.

h) Provisions have been included regarding the anchoring of various non-structural elements and building services to ensure their proper securing to the building structure.

j) Provisions have been added for construction in marine, hill, and snow-bound areas, addressing the unique challenges posed by these environments.

m) Provisions regarding the construction and installation of non-structural elements, finishes, building services, glass fixing, and building maintenance unit restraints have been included in **8.4.4**.

n) Provisions regarding the proficiency requirements of construction engineers including structural engineers have been included in **8.1.1**.

p) Provisions regarding thermal insulation practices for glass and glazing have been added in **8.4.6**.

q) Provisions have been added in **7.4** for the development and implementation of an emergency response and disaster management plan at construction sites, particularly for hazard-prone projects.

r) References to all the concerned Indian Standards have been updated.

Users are encouraged to employ suitable construction management software as an aid to implement provisions of this Code. The guidelines may be applicable in general to all construction projects. However, for smaller projects, the applicability of various provisions may be decided appropriately by the parties concerned.

Provisions on sustainable building construction practices are covered in Part 11 'Approach to Sustainability' of the Code.

The information contained in this Part is largely based on the following Indian Standards and Special Publications:

IS 3696	Safety code for scaffolds and ladders
(Part 1) : 1987	Scaffolds
(Part 2) : 1991	Ladders
IS 3764 : 1992	Code of safety for excavation work (*first revision*)
IS 4082 : 1996	Recommendations on stacking and storage of construction materials and components at site (*second revision*)
IS 4130 : 2024	Safety code for demolition of buildings (*third revision*)
IS 4912 : 1978	Safety requirements for floor and wall openings, railing and toe boards (*first revision*)
IS 5121 : 2013	Code of safety for piling and other deep foundations (*first revision*)
IS 5916 : 2013	Safety code for construction involving use of hot bituminous materials (*first revision*)

IS 7205 : 1974	Safety code for erection of structural steel work
IS 7969 : 1975	Safety code for handling and storage of building materials
IS 8989 : 1978	Safety code for erection of concrete framed structures
IS 13415 : 1992	Safety code for protective barrier in and around buildings
IS 13416	Recommendations for preventive measures against hazards at work places:
(Part 1) : 1992	Falling material hazards prevention
(Part 2) : 1992	Fall prevention
(Part 3) : 1994	Disposal of debris
(Part 4) : 1994	Timber structures
(Part 5) : 1994	Fire protection
IS 13430 : 1992	Code of practice for safety during additional construction and alteration to existing buildings
IS 15883	Guidelines for construction project management:
(Part 1) : 2009	General
(Part 2) : 2013	Time management
(Part 3) : 2015	Cost management
(Part 4) : 2015	Quality management
(Part 5) : 2013	Health and safety management
(Part 6) : 2015	Scope management
(Part 7) : 2021	Procurement Management
(Part 8) : 2015	Risk management
(Part 9) : 2018	Communication management
(Part 10) : 2021	Human resource management
(Part 11) : 2021	Sustainability management
(Part 12) : 2016	Integration Management
IS 17893 : 2023	Work permit system – Code of Practice
IS 16601 : 2016	Guidelines for habitat and welfare requirements for construction workers

A reference to SP 62 : 1997 'Handbook on building construction practices (excluding electrical work)' and SP 70 : 2001 'Handbook on construction safety practices', may also be made.

All standards, whether given herein above or cross-referred to in the main text of this Part, are subject to revision. The parties to agreement based on this Part are encouraged to investigate the possibility of applying the most recent editions of the standards.

For the purpose of deciding whether a particular requirement of this Code is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this Part.

Code users are requested to share their inputs/comments on the draft particularly based on the changes listed above in the foreword; and specially on those text highlighted in yellow in this draft.

Important Explanatory Note for Users of the Code

In any Part/Section of this Code, where reference is made to **'good practice'** in relation to design, constructional procedures or other related information, and where reference is made to **"accepted standard"** in relation to material specification, testing, or other related information, the Indian Standards listed at the end of the Part/Section shall be used as a guide to the interpretation.

At the time of publication, the editions indicated in the standards were valid. All standards are subject to revision and parties to agreements based on any Part/ Section are encouraged to investigate the possibility of applying the most recent editions of the standards.

In the list of standards given at the end of a Part/Section, the number appearing within parentheses in the first column indicates the number of the reference of the standard in the Part/Section. For example:

a) Good practices [7(1)] refers to the Indian Standard(s) given at serial number (1) of the list of standards given at the end of this Part/Section, that is, IS 7337 : 2020 'Project management - Glossary of terms (*third revision*)', IS 10400 : 2013 'Glossary of terms in inventory management (second revision)', and IS 15198 : 2014 'Glossary of terms in human resource development'

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Draft **National Building Code of India**

PART 7 CONSTRUCTION MANAGEMENT, PRACTICES AND SAFETY

[Fourth Revision of SP 7 (Part 7)]

(ICS No. 01.120: 91.040.01)

National Building Code Sectional Committee, CED 46	**Last Date for Comments: 06 April 2025**

1 SCOPE

1.1 This Code (Part 7) covers construction project management; construction planning, site management and building construction practices; storage, stacking and handling of materials; and safety of personnel during construction operations for all elements of a building and demolition of buildings; and habitat and welfare requirements for workers. It also covers guidelines relating to repairs, retrofitting and strengthening of buildings.

1.2 The provisions in respect of sustainable building construction practices are covered in Part 11 'Approach to Sustainability' of the Code which shall be used in conjunction with this Part.

1.3 Provisions relating to maintenance management are covered in Part 12 'Asset and Facility Management' of the Code which has been referred to in this Part.

2 TERMINOLOGY

For the purpose of this Part, the following definitions shall apply, and for other terms those given in the accepted standards [7(1)] shall apply.

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'.

2.2 Definitions relating to Building Information Modelling (BIM)

2.2.1 *Building Information Modelling* – The use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions.

NOTES -

1. Built assets include, but are not limited to, buildings, bridges, roads, process plants.
2. BIM implementation specifications can include BIM execution plans, definitions of style and content of deliverables such as types of drawing or schedule, and rules for preparing deliverables such as information container naming conventions.

2.2.2 *BIM Execution Plan (BEP)* – The plan that explains how the information management aspects of the appointment will be carried out by the delivery team. The term plan in BEP refers to a response to the employers information required (EIR) and is delivered either as online input or as a compiled document to the appointing party.

NOTE – There are two complementary versions of BEPs: 'Pre-appointment' BEP proposed by each prospective delivery team during the tender process; and 'Post-appointment' BEP delivered by the selected delivery team.

2.2.3 *BIM Uses* – It is the approach on how different project stakeholders utilize BIM when it is developed the required level of development (LOD) is termed as BIM Uses. 2D documentation, 3D detailing, BIM/GIS overlapping, energy simulation, sustainability analysis, etc are few examples of BIM.

NOTE – It is a prerequisite to understand the project type, project goals, and BIM Uses relationships to choose the right set of BIM Uses for any project delivery.

2.2.4 *Common Data Environment (CDE)* – A solution that is server-based or cloud-based technology with database management, transmittal, issue tracking, and related capabilities that support the CDE.

2.2.5 *Employers Information Requirement (EIR)* – Document(s) clarifying the employer's requirements during services' procurement which may include levels of modelling detail, training/competence requirements, ordinance systems, exchange formats or other employer-mandated processes, standards, or protocols.

2.2.6 *Level of Development (LOD)* – A standardized framework for defining the amount of detail and accuracy that should be included in a BIM at different stages of a project. LOD is measured as LOD 100, LOD 200, LOD 300, LOD 350, LOD 400, LOD 500 and LOD 500+.

2.2.7 *Open BIM* – A format that allows each project member to access the information model without hampering the native design. It is a universal approach to collaborate with design, realize, and operate buildings based on open standards like IFC (International Foundation Class), BCF (BIM Collaboration Format) and others.

2.3 Definitions relating to Safety in Construction

2.3.1 *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.

2.3.2 *Floor Hole* – An opening measuring less than 300 mm but more than 25 mm 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.

2.3.3 *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.

2.3.4 *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.

2.3.5 *Materials Handling 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.

2.3.6 *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.

2.3.7 *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.

2.3.8 *Scaffold* – A temporary structure consisting of standards, putlogs, ledgers, generally of bamboo, *Ballies*, timber or metal to provide a working platform for workers and materials in the course of construction, maintenance, repairs and demolition, and also to support or allow hoisting and lowering of workers, their tools and materials.

2.3.9 *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.

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

2.3.11 *Wall Opening* – An opening in any wall or partition having both height of at least 750 mm and width of at least 450 mm.

3 GENERAL

3.1 A general overview of construction project management and information regarding the applicable tools and techniques are covered in Section 1 ‘Construction Management’ of this Part, which also demarcates various stages of a construction project and activities thereunder. Section 1 gives brief guidelines on project formulation and appraisal, and various construction project management functions; and for detailed guidelines on each of these, gives reference to the available good practices.

Construction planning and site management, plays an important role in smooth progress of a building construction activity and are covered in Section 2 ‘Construction Planning and Site Management’. The knowledge of actual technical provisions in regard to practices relating to various building components starting from sub-structure to super-structure, play a key role in achieving the quality of building construction. Also, temporary enabling works; proper stacking and storage of materials; and well planned handling operations, have important role in proper, safe and smooth progress in construction work at site. The provisions in respect of these are covered in Section 3 ‘Construction Practices’.

The objectives of sound construction of buildings having requisite quality, durability and finish has to be duly dovetailed with the goals of safety whether during construction of a new building or addition/alteration to an existing building part thereof or during demolition

of an existing building. Section 4 'Safety in Construction and Demolition' covers provisions to these effects.

Section 5 'Repairs, Retrofitting and Strengthening of Buildings' covers repair, retrofitting and strengthening of existing buildings and Section 6 'Habitat and Welfare Requirements for Workers' deals with habitat and other welfare requirements for construction workers at site.

3.2 The objective of universal design and accessibility is to ensure that all users, including those with disabilities and elderly people are able to access all the facilities within the built environment including in the public buildings, on an equal basis. Requirements for accessibility in built environment for the elderly and for persons with disabilities as given in **13** of Part 3 'Development Control Rules and General Building Requirements' of the Code shall be complied with at all stages of the construction project.

SECTION 1 CONSTRUCTION MANAGEMENT

4 CONSTRUCTION PROJECT MANAGEMENT

4.1 General

4.1.1 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 good practice [7(2)]. Information and guidelines given under **4.1.2** to **4.1.6** shall be appropriately utilized under different stages of construction project.

4.1.2 *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 and may positively or negatively impact the project. 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.

4.1.3 *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 stage-wise 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.

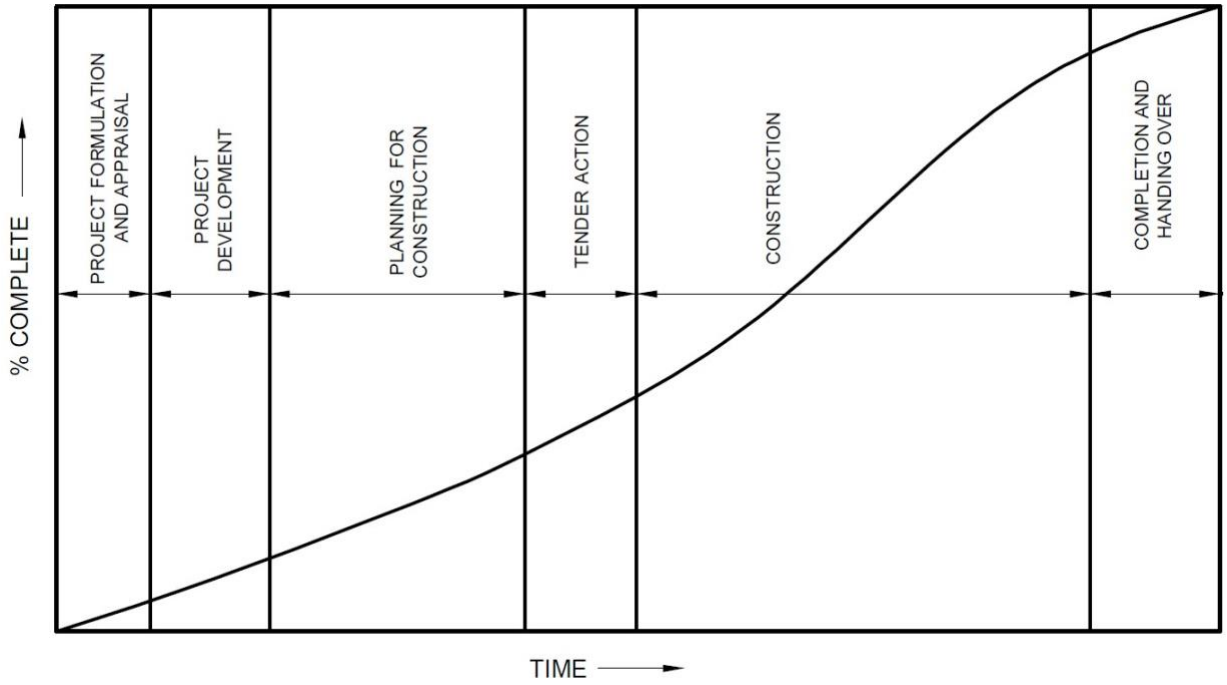


FIG. 1 TYPICAL CONSTRUCTION PROJECT LIFE CYCLE

4.1.4 *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.

4.1.5 *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.

4.1.6 *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.

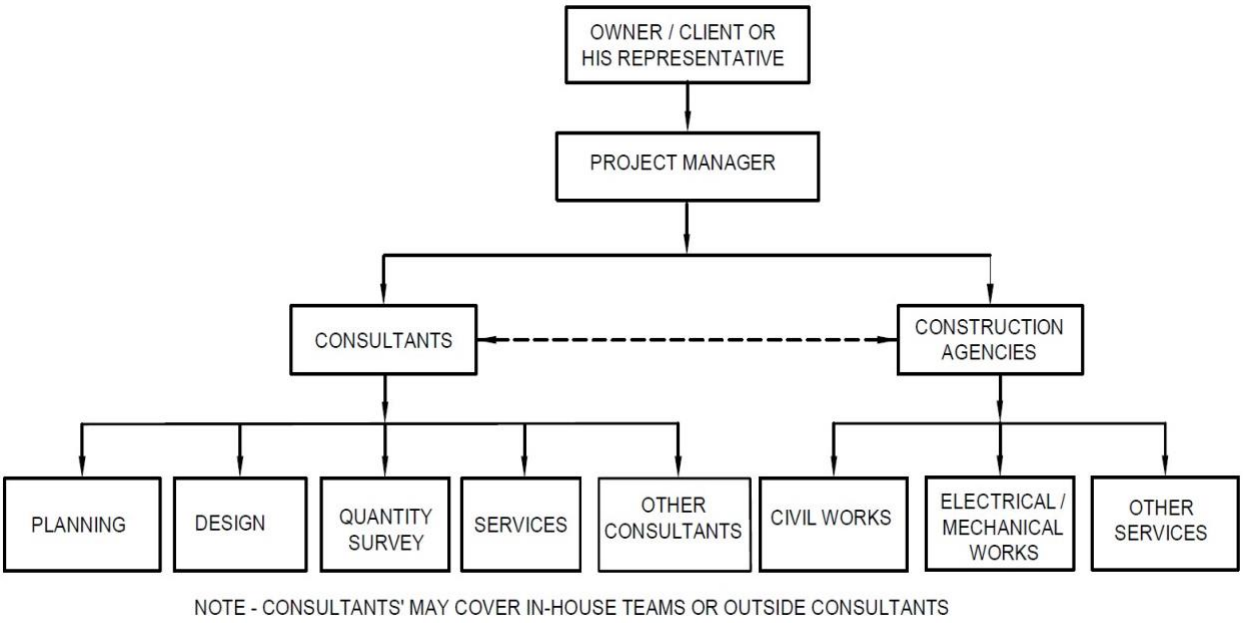


FIG. 2 TYPICAL ORGANIZATION STRUCTURE FOR DESIGN-BID-BUILD MODEL

4.1.6.1 *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.

4.2 Stages of a Construction Project

4.2.1 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.

4.2.2 *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 good practice [7(2)] 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 **4.3** should be employed for achieving the intended objectives.

4.2.3 *Pre-Construction*

4.2.3.1 *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;
j) Preliminary cost estimates;
k) Detailed planning and design of each discipline;
m) Construction working drawings and related specifications with integration of engineering inputs of all concerned disciplines;
n) Detailed cost estimates;
p) Detailed specifications and bills of quantities; and
q) 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.

4.2.3.2 *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.

4.2.3.2.1 *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.

4.2.3.2.2 *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 good practices [7(3)]. Network schedule shall be prepared for all disciplines and they shall be integrated into a master control schedule.

4.2.3.2.3 *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 re-allocating the slack resources from non-critical 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.

4.2.3.2.4 *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.

4.2.3.3 *Tender action*

4.2.3.3.1 *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* **4.2.3.1**) 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.

4.2.3.3.2 Selection of construction agency

Selection of construction agency 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 for the project; or

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.

NOTE — Electronic tendering could also be considered.

4.2.3.3.3 *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.

4.2.4 *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 **4.3** and particularly through procurement management, time management, cost management, quality management and health, safety and environment management.

4.2.5 *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) Taking approvals from government agencies like Fire department etc.
g) Preparation of maintenance manual,
h) Performance compliance verification of built facility,
j) Handing over all other required documents, including guarantees, to the client/owner,

k) Restoration of surroundings, and
l) Preparation and handing over all as-built drawings in physical or electronic form.

4.3 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,
j) Health and safety management,
k) Sustainability management,
m) Integration management, and
n) 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.

4.3.1 *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 good practice [7(4)].

4.3.2 *Procurement Management*

Procurement process is one of the essential elements of construction project management, through which works, goods, and services are procured systematically. This process includes initiating, managing, and completing contracts, ensuring the successful delivery of goods, works and services, completion of work, or conclusion of

services. It starts with identifying the requirements and ends with the procurement process's conclusion.

The scope of procurement management is to establish and maintain processes and relationships with planning and design consulting firms, contractors, and vendors/suppliers throughout the project's duration. The procurement management plan shall be prepared and defined during the planning stage and applied and updated throughout the construction activities.

Procurement management involves documenting the need and scope, specification development, deciding on the procurement strategy, tender actions, evaluating tenders, negotiating, awarding, entering into agreements, and managing contracts. The scope during the construction stage also includes procurement schedule, procurement management plan, procurement operations, and contract management, whereas during the post-construction and closure stage, it includes outcome of procurement operations and documenting lessons learned.

The execution of these processes depends on the project size, policies, and complexities, with recent financing advances influencing the process. Key attributes include fairness, equitability, transparency, competitiveness, and cost-effectiveness, while also addressing objectives like social security and the promotion of indigenous materials and processes.

The organizational structure for procurement management depends on the project delivery model. The owner must establish a documented procurement system that includes the organization’s strategies and policies. This documentation shall generally cover standard procurement procedures for each category, essentials of documentation, reporting and approval systems, clear indications of legal and statutory requirements, publicity requirements and arrangements for calling bids, standard forms of contract and industry standards, requirements for bid security, security deposit, and other retention requirements, basic insurance requirements, quality standards, and health, safety, and environment standards to be followed. It also includes detailed procedures for handling departures from specified procedures. Procurement can be publicly funded, privately funded, or through public-private participation. Type of contracts under traditional routes include rate contract, item rate contract, percentage contract, and lump-sum contracts, while other delivery systems may involve design and build, engineering, procurement and construction (EPC), turnkey contracts, or public private partnership (PPP). The employer shall promote e-tendering for transparency and efficiency, ensuring the system is secure and accessible.

Procurement monitoring is the process of monitoring the procurement plan for its successful completion of procurement actions. Key aspects include monitoring schedule, management information system (MIS), communication, document management, and pre-completion finalization.

Procurement closure is the process of completing each procurement of works/ goods/ services as per procurement management plan. All agreements and related amendments shall be documented and maintained for future reference. The contract terms and conditions shall prescribe specific procedures for agreement closure. This process includes procurement audits, document management system, physical closure, financial closure, final dispute settlement, and lessons learnt.

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

4.3.3 *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 good practice [7(6)].

4.3.4 *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.

For detailed guidelines, reference shall be made to good practice [7(7)].

4.3.5 *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.

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

4.3.6 *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 good practice [7(9)].

4.3.7 *Communication Management*

Communication involves sharing information such as knowledge, data, and skills, and is crucial for the success of complex projects like construction. Effective communication is essential as it ensures that various teams, including client team, consultant team and construction team, work together seamlessly, even when they are located in different places and time zones.

Communication in construction can be categorized into the following five main types namely:

a) Inter-office communication (between head office team of participating organizations)
b) Intra-office communication (between branch offices of respective participating organizations or between their head office and branch offices,
c) Site communication (between project sites and head offices of participating organizations),
d) Intra-site communication (among project execution team members at the same site), and
e) Communication with statutory bodies.

Effective communication tools include E-mail, hard drives, local area networks, transmittals, fax, courier, traditional mail, collaboration systems, FTP sites, CD, DVD, wireless networks (Wi-Fi, bluetooth, infrared), cloud storage and similar other latest technologies. While verbal communication is important, it should be documented to prevent misunderstandings. Written communication is essential for accurate documentation management, requiring systematic logging, distribution, action, and filing of incoming correspondence. Adherence to project-critical response deadlines, maintenance of a suspense file for pending actions, and substitution protocol for authorized signatories are crucial, alongside compliance with organizational standards for fonts and layout across all documentation. A project-specific procedure shall be developed for handling and archiving E-mails, ensuring that all E-mails containing key decisions or critical documents are printed and retained, with communication protocols and standards for E-mail use, formatting, and signatures established at the start of the project. Online collaboration systems in construction help build effective work practices on projects by supporting each stakeholder to perform and be accountable for their contracted activities. In order to increase adoption, a platform should act as a neutral party where everyone on the project feels that the relevant project information is shared with the relevant project participants.

The benefits of effective communication are significant at different stages of a construction project. During the pre-construction stage, client can communicate in a structured way with key consultants such as the design team, project manager, quantity surveyor, etc. In the construction stage, it helps in efficiently managing large file distribution, contract documents, and agreements of all contractors and vendors. In the commissioning and handover stage, effective communication ensures the accurate development of as-built drawings and manuals, the proper management of essential services certification, and the efficient handover of documentation to the client for retention and facility management.

To manage communication effectively, it is essential to identify all involved groups, relationships, logistics and information needs. Implementation steps include finalizing

communication agreements in contracts, assessing the compatibility of resources, and planning training for staff.

The assessment of communication technology and management shall consider interoperability requirements, connectivity, confidentiality of information, document retention and archiving, data security, intellectual property rights protection, legal validity of digital copies, communication protocols, and storage, including evaluating online collaboration systems, associated costs, and compliance with the *'The Information Technology Act, 2000'*.

Monitoring of communication to ensure the communication plan is effective, it should ideally be initiated from the pre-construction stage of the project. All organizations and vendors, who get associated with the project at different stages of the project should be contractually bound to adopt the 'communication management plan' as applicable and protocols established for it.

Periodic audits are needed to check if the communication system is working well. The results of the audit will lead to updates in the communication management plan, discussions with team members about any issues related to the plan, and possibly re-training or process changes. 'Communication management audit' would be planned and structured earlier in 'plan communication management' stage and would be part of planning.

For detailed guidelines, reference shall be made to good practice [7(10)].

4.3.8 *Human Resource Management*

Every construction project is unique, and its successful delivery depends on the experience, competence, and skills of human resources throughout the project life cycle. Construction projects have significant and varied human resource requirements depending on the project's stage and type, these need to be sourced, shortlisted, selected, deployed, developed and inspired from the pre-construction stage of the project to final close out stage to achieve the intended purpose, desired quality, at reasonable cost, and within an acceptable timeframe.

The requirements prescribed in various central and state regulations including *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act*, 1996 and rules framed thereunder with respect to managing safety and well-being of human resource in construction projects, shall be complied with. The organizational structure for human resource management depends on the project delivery model, size of the project, procurement route, delivery model, and construction methodologies. On large and medium value projects, a separate human resource management team for each agency, which would report directly to the project manager, may be necessary. In smaller projects, this role may be integrated with other functions.

Human Resource Management requirements are as follows:

a) The agencies involved in project development, including the owner, consultant, and contractor, shall jointly or separately create a written statement outlining the human resource policy of the organization. The human resource management policy conveys the management commitment and intent regarding human

resource recruitment, training/ development, wages, performance appraisal, welfare/amenities and safety in construction. To address the safety, health, and environmental aspects of human resources, the policy shall meet the requirements of *Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996,* and rules framed thereunder, as well as IS/ISO 45001, and IS 15883 (Part 5). It shall be communicated to all stakeholders and displayed in the local languages understood by the majority of workmen.

b) The most important resource for a project is its people, the project team, which requires specific expertise at various stages of the life cycle of the project. Expertise can be mobilized either from internal resources (employees on payroll) or by recruiting contract workers to meet the specific needs of the project. The human resource plan shall explain the means of establishing a positive human resource development culture within the project. It shall identify and enumerate the control measures to mitigate the risks to the project completion arising from human resource issues, ensuring that the project proceeds without interruption and is executed according to schedule. The following salient aspects may be covered in the project human resource plan:

1) Project specific human resource qualitative requirements based on stage of the project and client's requirements;
2) Legal and other statutory requirements including minimum wages, provident fund and miscellaneous provisions as per the various acts/ regulations like contract labour, migrant labour acts, etc. for employees and other personnel including sub-contractors/piece rate workers, etc.
3) Human resource organization;
4) Welfare and health/medical needs and services;
5) Human resource requirements to be followed by sub-contractors/consultants;
6) Safety of employees and sub-contractors/labour;
7) Skill-set and training of the workmen;
8) Training and development of managers, officers and supervisors;
9) Human resource appraisal and performance monitoring system;
10) Promotion and reward/development based on objective performance appraisal; and
11) Other aspects of HR

c) Further, the principal functions of the human resource management team in a project are as follows: planning for human resources which involves establishing roles, responsibilities, reporting relationships, and creating a staff management plan; building project team by mobilizing required resources; developing project team by keeping the mobilized resources motivated; managing project team by identifying skill-set gaps; training and skill improvements; updating skill inventory by maintaining and updating skill register against each resource deployed; demobilizing project team by demobilizing the resource on timely basis and site administration and accounting.

d) Planning process for Human resource shall be carried out by identifying, documenting, assigning the project roles, responsibilities, and reporting relationships. The human resource management plan shall be developed by

identifying a set of activities to be performed at each stage of the project; preparing an execution strategy to accomplish project objectives and identifying the skills required for implementing that strategy; change and configuration management plans; monitoring and updating the schedules/updates may sometimes require revision of baselines as a result of change in scope; the alteration to the human resource plan if any to meet the revised execution plan of the project; communication needs and methods (keeping stakeholders informed).

e) The human resource management also include processes such as human resource planning tools and staff management plan, as well as building project team for effective human resource sourcing for project teams. The HR management team shall continuously develop and manage project teams by improving individual competencies, fostering team cohesion, tracking performance, providing feedback, resolving conflicts, and utilizing tools such as project performance appraisals and interpersonal skills to achieve project objectives. The HR management team shall regularly update the skill inventory to identify skill gaps and ensure proper redeployment, while the timely demobilization of project resources shall be initiated prior to project completion to optimize cost efficiency and resource productivity.

Induction for new construction workers should be conducted prior to commencing work and should include company introduction, site layout, safety policies, hazard identification, risk management, personal protective equipment usage, emergency procedures, tool handling, scaffold safety, site security, and environmental protocols. A question-and-answer session may be conducted to address worker queries, followed by a signed declaration confirming their understanding.

For detailed guidelines, reference shall be made to good practice [7(11)].

4.3.9 *Occupational Health and Safety Management*

Effective management of occupational health and safety (OH&S) is vital for minimizing risks and safeguarding worker well-being throughout the lifecycle of construction projects. The provisions discussed below establish the framework for implementing OH&S management systems, tailored to projects of varying sizes and complexities, with reference to [7(12)] for good practices.

4.3.9.1 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.

4.3.9.2 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.
j) 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 (Regulation of Employment and Conditions of Service) Act*, 1996. Safety officer who is posted at a medium to major construction site shall:

a) Look after the safety of the personnel, safe handling of materials and machinery, safe work practices and standard operating procedures.
b) Be responsible for compliance of all statutory obligations of the employer in regard to safety of personnel and structures.
c) Guide and assist the site managers/engineers to make their sites safe and accident free.
d) Train personnel in construction safety, conduct safety surveys and design suitable documents for recording and promoting safety on sites and in the construction industry.
e) Arrange for safety briefing for all the persons entering the construction area.

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

4.3.9.3 *Management System Considerations*

4.3.9.3.1 The project size and scale of consideration shall be as follows:

a) *Small to medium projects* – For small to medium-sized projects characterized by lower complexity and risk, the OH&S management system shall focus on essential practices such as hazard identification, risk assessment, and emergency preparedness. Documentation and procedures should be proportionate to the project's size and risk profile, emphasizing practicality while ensuring effective safety measures. Implementing good practice [7(12)] can facilitate straightforward integration of safety protocols without imposing excessive administrative burdens.

b) *Large and high-risk projects* – In large-scale or high-risk projects, where complexities and hazards are heightened, a comprehensive application of OH&S management systems shall be required. This includes detailed documentation of safety protocols, regular audits, and ongoing compliance monitoring. Organizations should pursue third-party certification in alignment with good practice [7(12)] to demonstrate their commitment to safety standards and best practices.

4.3.9.3.2 The implementation and monitoring aspects cover the following:

a) *Safety management systems* – OH&S management systems shall include mechanisms for continuous monitoring of safety performance, active worker involvement, and periodic reviews. These systems should be designed to adapt to the specific needs of each project, ensuring that safety protocols are dynamic and responsive to changing conditions and risks. Adopting principles in accordance with best practice [7(12)] can enhance the effectiveness of these safety systems, fostering a proactive safety culture.

b) *Documentation and compliance* – Safety documentation should align with OH&S management system guidelines, ensuring comprehensive coverage of risk assessments, incident management, and audit findings. The detail and complexity of this documentation shall correspond to the scale and risk profile of the project, maintaining efficiency while providing robust safety oversight. The best practice [7(12)] provides a valuable framework for developing this documentation to support effective safety management and compliance.

4.3.9.3.3 *Flexibility in application*

The implementation of OH&S management systems should allow for flexibility based on the of the project size and specific risk factors. Smaller projects may adopt simplified safety management practices, provided they adhere to the fundamental principles of hazard identification, risk mitigation, and worker protection. Nevertheless, all projects shall uphold a consistent commitment to occupational health and safety, guided by the best practice [7(12)], to ensure a safe working environment for all stakeholders involved.

4.3.9.4 A pre-medical examination should be conducted for all construction workers prior to employment to ensure they are physically fit to handle the demands of the job, which may include strenuous tasks, exposure to harsh environments, and operation of heavy machinery. The examination should assess the worker's overall health and fitness to safeguard both their safety and project efficiency.

4.3.10 *Sustainability Management*

Sustainable development is key to tackling the linked challenges of climate change, resource use, economic prosperity, and social well-being, and cannot be achieved without sustainable design and construction. Sustainable design and construction bears upon developing the design proposal, which is efficient in terms of functional performance as well as detailed out to ensure that the material resources and construction technologies are used efficiently during the construction stage. Construction practices that execute design proposals, which inherently cause higher wastages and do not facilitate efficient planning, should be avoided. Following are the principal objectives of sustainability management:

a) Minimizing adverse environmental impact of construction activities, products, and services.
b) Limiting any adverse impact within the laws/prescribed norms and their monitoring.
c) Protection of the environment while working with hazardous material.
d) Reduction and management of disposal of waste from construction sites.

e) Considering positive environmental contribution.
f) Developing systems and procedures for achieving sustainability objectives.
g) Putting in place systems to minimize damage at the site due to natural and man-made disasters.

The objectives given above define the scope of the sustainable design and environmental management of the project site, and to achieve these objectives a structured methodology must be adopted at various stages of construction. This includes identification of issues during project planning and designing stages, identification of issues at pre-construction stage, identification of issues during construction stage, preparation of sustainability construction management plan and implementation and monitoring of sustainable construction management plan. Additionally, social and environmental impact assessments should be conducted according to statutory guidelines based on the type and size of the project. Establishing an effective site organization structure, considering management systems and agencies involvement in construction is very critical for clear interfaces and coordinated decisions, which help prevent wastage of resources, reworks, rejections, delays, and such other non-conformities affecting quality and execution.

Sustainability management in design and construction includes the following:

1) *Identification of issues at the project planning and designing stages* – The project planning should be detailed out so that use of materials and technologies may be planned in advance. Design detailing should facilitate planning of procurement of materials in sizes, volumes and lots, minimize wastage, and align with available material sizes, shapes, volumes and local or regionally sourced material. Design should, therefore coordinate to incorporate quality and quantity aspects from the construction perspective.

   The generalized design process for sustainable construction should address the following considerations: set the design parameters to be equal to or higher than benchmarking standards prescribed in Part 11 'Approach to Sustainability' of the Code; adapting basic performance requirements and set standards to climatic zones and geological conditions; address requirements of performance and human comfort; identify their optimum levels in long-term scenarios; ensuring sustainable systems for decades; promoting a holistic approach; maximize the use of traditional wisdom in design and construction; assessing new materials and technologies for long-term impact; taking decision-making to measurable levels; and take the savings benchmark targets closer to the minimum consumption standards. To ensure sustainable development, it's important to plan for all stages of a structure's life cycle, from concept, design, construction, commissioning, operation and maintenance, and also decommissioning and disposal at the end of the useful life of structure. This involves reusing and recycling materials to close the resource loop (cradle to cradle). Technology options shall be a combination of natural and manmade materials with least embodied energy and include rapidly renewable resources.

   The designs, materials, and technologies, construction practices should be selected in such a way so as to minimize both overall embodied and operational energy in built facility. The construction should promote local sustainability through adoption of local resources (natural and man-made) and local skills. All

stakeholders shall actively participate in training and awareness initiatives to address sustainability development at all stages of building lifecycle (from design to end of life). Additionally, the environmental impact assessment should be carried out and remedial measures based on the findings should be taken during the life cycle of the buildings.

Environmental Impact Assessment (EIA) undertakes characterization of the existing status of the land, water, air, biological, and socio-economic environments in the project area, and to identify potential environmental impacts of the project, and formulation of an effective environmental management plan (EMP) to prevent, control and mitigate the adverse environmental impacts, and ensuring the compliance with the environmental legislations. The EIA and EMP outline the scope for planning, monitoring, and controlling environmental descriptors during construction phase, including soil monitoring, water quality monitoring, ambient air quality monitoring, noise monitoring, landscape, biodiversity and site dereliction, and traffic studies.

2) *Identification of issues during the pre-construction stage* – It involves the preparation of Sustainability Construction Management Plan, site planning and determining the location of facilities for hazardous materials to ensure safe and efficient management. The management plan documents the approach to site management, project management processes, systems for management, site organization, data inputs to determine effectiveness of management systems and site planning.

3) *Contractual obligations towards sustainable construction* – Contracts determine obligations of individuals and organizations. The contracts shall make it obligatory on the part of the suppliers (materials, equipment or services) to follow sustainable practices and processes. These binding obligations ensure system-wide responsibilities, allowing for the budgeting of resource mitigation within the project scope.

4) *Establishment of construction project management processes* – For achieving sustainable construction objectives, establishment of effective project management processes is required. Some basic project management processes include time, cost, quality, scope, risk, procurement, human resource, health, and safety aspects. Reference should be made to good practice [7(14)] for detailing out construction project management processes.

5) *Construction stage processes* – Minimising energy consumption at construction stage, work education procedures, construction waste management and material management.

For detailed guidelines, reference shall be made to good practice [7(15)].

4.3.11 *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 down-stream processes and activities.

For detailed guidelines, reference shall be made to good practice [7(16)].

4.4 Roles of the Construction Management Team and Supervisory Team

4.4.1 *Roles of Construction Management Team*

The primary functions of the construction management team include overseeing specific tasks during the construction phase and managing the overall construction-related work. The construction management team is responsible for key tasks such as cost management, on-site inspections, and change management. They are also responsible for assigning supervisors with the necessary supervisory skills to identify existing construction gaps and anticipate hazards in the surroundings or working conditions. The construction management team shall authorize the supervisory team to take prompt corrective measures within their scope and escalate more significant issues to management for further action.

4.4.2 *Roles of the Supervisory Team*

The supervisory team represents the first level of management on-site. Their primary responsibility is to supervise, coordinate and schedule daily activities involving crews and contractors, ensuring that the work is executed according to the established standards and undertaken with the necessary safety measures. The team shall plan proactively to prevent non-compliance. In the event that any part of a directive conflicts with or falls below the required standards, the supervisory team is authorized to issue a stop-work order and escalate the matter to take prompt corrective measures. This involves analysing, eliminating and mitigating associated risks and issues.

The supervisory team shall assist the construction management team by offering planning support and providing feedback based on their practical site experience and knowledge of the workforce. Supervisors are responsible for briefing teams, identifying areas for improvement, maintaining records and information, and resolving disputes. Supervisory teams shall possess essential skills such as effective communication, performance management, motivation, team development and problem-solving skills.

5 BUILDING INFORMATION MODELLING

5.1 General

Building Information Modelling (BIM) is all about generating and using the information generated during the project life cycle. Generating BIM is the first phase and using of generated BIM is the second phase activity. Generating BIM is a combined effort of design and engineering team, whereas usage of generated BIM is an approach which each project team has to work out. BIM matures during the design, construction and operation phases with respect to graphical, parametric (dimensions, material, textures) and documents. Generated BIM becomes the single point of truth for project stakeholders and enables better coordination, collaboration and communication.

BIM is applicable to all type of building sector project such as residential, educational, institutional, assembly, business, mercantile, industrial, storage, hazardous and mixed use building projects. BIM can be enabled for a project by developing an information rich model to perform time (4D BIM) and cost (5D BIM) planning and monitoring, safety and risk assessment, procurement and logistics planning, design and engineering analysis such as structural, lighting, wind, earthquake and energy.

BIM will bring multiple stakeholders on a Common Data Environment (CDE) – Platform to enable information management by project stakeholders to have a better experience by integrating BIM for experience (virtual, augmented and mixed reality). BIM lays a foundation for activating modular construction [3D printing, Design for manufacture and assembly (DFMA), pre-fabrication], reality capture [drone, 360° camera, robots and laser scanners] and digital twin [building automation with BIM and Internet of things (IoT) integration].

5.2 Project Life Cycle Stages

Building a physical asset or modifying an existing asset during its service life comprises the following major stages. Here's a brief explanation of each stage in the context of BIM and digital transformation.

a) Stage 0 – Strategic Definition – Establish project objectives, feasibility, and high-level requirements. Define BIM goals and digital strategies.

b) Stage 1 – Preparation and Briefing – Develop project briefs, appoint key stakeholders, and establish the BIM Execution Plan (BEP).

c) Stage 2 – Concept Design – Generate early design options, integrate BIM models, and conduct preliminary analyses.

d) Stage 3 – Spatial Coordination – Refine designs, resolve clashes through BIM coordination, and ensure multidisciplinary integration.

e) Stage 4 – Technical Design – Finalize detailed designs, ensure compliance with regulations, and prepare for construction.

f) Stage 5 – Manufacturing and Construction – Implement BIM for off-site fabrication, on-site coordination, and progress monitoring.

g) Stage 6 – Handover – Deliver as-built models, digital twins, and documentation for facility management.

h) Stage 7 – Use – Operate, maintain, and optimize the built asset using BIM data throughout its lifecycle.

Each stage necessarily requires project stakeholders to work together in maturing the BIM from LOD 100 to 500+. The BIM generated during this process is referred to digital asset.

5.3 Project Stakeholders

The key stakeholders in construction projects are classified as the appointing party, lead appointed party, and appointed parties, each playing distinct roles in information management and project delivery.

5.3.1 The appointing party is typically the project owner or client responsible for initiating the project, defining the Exchange Information Requirements (EIR), and setting the framework for information delivery to meet the project's objectives. They appoint a lead appointed party, such as a primary consultant, contractor, or design team leader, who serves as the main coordinator of information across the project.

5.3.2 The lead appointed party takes responsibility for developing and implementing the BIM Execution Plan (BEP), ensuring compliance with the appointing party's requirements, and managing the collaboration between various teams.

5.3.3 The appointed parties, which can include subcontractors, specialist consultants, or suppliers, work under the direction of the lead appointed party and contribute their specific expertise and information to the project.

This hierarchical structure ensures a clear flow of responsibilities, enabling efficient information management, collaboration, and alignment with the project's goals throughout its lifecycle.

Appropriate multi-disciplinary teams need to be constituted to successfully meet the requirements of different stages. Each team may comprise need-based professionals out of the following depending upon the nature, magnitude and complexity of projects.

1) Architect
2) Civil Engineer
3) Structural engineer
4) Mechanical (HVAC) engineer
5) Electrical engineer
6) Plumbing engineer
7) Fire protection engineer
8) Vertical transport specialist
9) Acoustics specialist
10) Health, safety and environmental specialist
11) Sustainability specialist
12) Landscape architect
13) Interior designer
14) Planning engineer
15) Quantity surveyor
16) Information manager

17) Quality assurance/control engineer
18) Safety Officer
19) Design manager
20) Construction manager
21) Facility manager
22) Project manager
23) BIM Modeller
24) BIM Specialist
25) BIM coordinator
26) BIM Manager
27) BIM Head
28) BIM Advisory
29) Other subject specialists

5.4 BIM Skills and Competencies

It is important that project stakeholders from design, construction and operation teams are possessing the necessary BIM skills and competencies depending on the type and complexity of the project. It is clear that above set of professionals are categorized in production, management and leadership roles in BIM projects considering their qualification, experience and expertise in BIM Implementation and strategy. Each stakeholder works on Common Data Environment (CDE) platform.

5.4.1 *Design team*

Design team in building projects comprises architects, structural, mechanical, electrical, plumbing, fire protection, vertical transport, acoustics, sustainability, health, safety and environmental specialists and interior designer. Each stakeholder in design team shall be good at generating and maturing BIM from LOD 100 to 500. And, they shall be skilled to use the BIM to activate appropriate BIM Uses.

Architecture and landscape specialist use BIM for identifying design options, area and space program validation, sun studies, day lighting, lighting analysis, to generate design-construction-as built drawings.

Structural engineers use BIM for structural analysis, shop drawing coordination, design-construction-as built drawing production.

Mechanical, electrical, plumbing and fire protection (MEPF) engineers use BIM for clash detection, to analyse equipment and maintenance clearance space, mechanical and energy analysis, to generate digital details and mock-ups, for prefabrication, shop drawing coordination, and to generate design-construction-as built drawings.

Interior designers use BIM for creating interiors in 3D and provide immersive experience to its clients through virtual reality and experience centre setup.

Sustainability specialist use BIM for simulation of green building credits achievability, energy analysis and lean workflows.

All the above stakeholders can utilize BIM for coordination meetings, ensuring alignment and facilitating the resolution of clashes during design discussions. Design managers

(BIM manager – Design) manages the team and their deliverables in this phase with BIM workflows. It is desirable that multi-disciplinary integration is initiated right from the concept design stage. To ensure proper implementation of the design, the design team, may be associated during the construction and handover stages.

5.4.2 *Construction Team*

Construction team in the building projects comprises planning engineers, quantity surveyors, quality assurance and control engineers, safety engineers, formwork specialist, the procurement & contracts team, as well as the stores, logistics and execution teams. The construction team should implement BIM for field activities.

Execution team on site includes civil (architecture and structure), MEPF, interior engineers etc. These stakeholders shall be proficient in capturing field data and share with design team to update the BIM into an as-built model / digital twin that is, LOD 500. They can use BIM for in-field construction layout.

Planning engineers can use BIM for time (4D BIM) planning and monitoring.

Quantity surveyors can use BIM for cost (5D BIM) planning and monitoring and cash flow analysis and reporting.

Quality assurance and control engineers can use reality capture for quality assessments.

Formwork specialist can use BIM for temporary structures modelling and simulation.

Safety engineers can use BIM to perform virtual design and construction (VDC) simulations to understand the risk and safety measures and subsequently train the site team.

Procurement and contracts, as well as stores and logistics team can use BIM to perform VDC simulations to understand look-ahead, construction material movement, labour sequencing, site planning for material delivery, staging and storage activities.

Reality capture team captures existing conditions on site using laser scanners, drones, 360-degree camera and cyber dogs. Data capture is performed during the completion of each phase like

a) Civil,
b) MEPF and
c) Architecture, landscape and interiors.

Construction managers (field BIM manager) shall manage the construction team and their deliverables and perform soft-landing of digital asset with physical asset during the handover stage. This team shall be responsible to achieve satisfactory completion of the project in respect of all relevant project management functions like cost, time, quality, safety, etc. BIM manager – Design shall be looped in actively during the project execution stage.

5.4.3 *Operations Team*

Operations team in building projects shall include the facility manager, building owners, occupants/end-users, service providers, regulatory authorities, suppliers/vendors, sustainability consultants and IT managers.

Facility manager shall use digital twin for overseeing day-to-day operations, maintenance and management of the facility. BIM uses include model usage for maintenance and maintenance training.

Building owners/end users can use digital twin integrated with IoT for building automation.

Sustainability consultants can use digital twin to perform energy analysis. This guides the implementation of energy-efficient and sustainable practices within the facility.

Suppliers/vendors can use digital twin to understand the materials, equipment and services for ongoing maintenance and operations.

IT managers can use digital twin to manage the building including automation systems and networks. This is achieved by integrating Computerized Maintenance Management System (CMMS) and Computer-Aided Facility Management (CAFM) data models. This can also be used for security studies on built assets.

Operation, maintenance and repairs also require a multi-disciplinary approach to ensure that all the requirements of the users are satisfactorily met. During maintenance and repairs, the jobs requiring inter-disciplinary coordination have to be executed in such a manner so as not only to cause least inconvenience to the user but also to ensure that there is no mismatch or damage to the structure, finishing, fittings and fixtures, and to preserve the integrity of other services.

5.5 Benefits of using Generated BIM

Activating BIM for project stakeholders offers numerous benefits, including improved collaboration, enhanced communication, and streamlined decision-making. With a centralized digital model, all stakeholders can access real-time data, reducing errors and rework while increasing project efficiency. BIM facilitates better visualization, allowing for more accurate planning and design, while its ability to detect potential conflicts early on reduces costly delays. Additionally, BIM supports sustainable practices by optimizing resource usage and energy efficiency, ensuring that stakeholders are better aligned throughout the project lifecycle.

Below section discuss the benefits to client, Architect and designer, Engineer, Cost consultant, planner and project manager, main contractor, specialist contractor, manufacturer and supplier, and facilities manager in each stage of project.

5.5.1 *Preparation Stage*

This initial phase focuses on defining project objectives, feasibility studies, and budgeting. Stakeholders assess site conditions, legal requirements, and environmental factors to establish a solid foundation for project planning.

a) Client: Better projections through sharing of requirements with all stakeholders. Earlier decision making.

b) Architect and Designer: Improved clarity of project brief and client / owner understanding.
c) Engineer: Improved access to information. Early input to feasibility planning, design, costs and improving the environmental impact.
d) Cost Consultant: Improved access to information and cost models. Enables earlier optioneering.
e) Planner and Project Manager: Improved access to information and early engagement.
f) Main Contractor: Supports early contractor involvement.
g) Specialist Contractor: Improved access to information.
h) Manufacturer and Supplier: Opportunity for early consideration of specialist equipment and materials.
j) Facilities Manager: Early-stage definition of COBie deliverables for Asset / Facilities management.

5.5.2 *Design Stage*

Architects, engineers, and consultants develop detailed plans and models, integrating technical specifications and stakeholder input. BIM tools are often used to optimize designs, ensure accuracy, and detect potential conflicts before construction begins.

a) Client: Earlier engagement and understanding of design proposals and options leading to earlier stabilization of the brief.
b) Architect and Designer: More effective design, review and co-ordination. Easier to assess options, costs and outcomes.
c) Engineer: Opportunity to influence and optimize design outcomes. Early-stage clash detection, specification and design enhancements.
d) Cost Consultant: Measurement and cost calculations semi-automated, resulting in being faster and more accurate.
e) Planner and Project Manager: Improved visibility of development and options.
f) Main Contractor: Opportunity to review / influence design outcomes.
g) Specialist Contractor: Opportunity to influence design outcomes.
h) Manufacturer and Supplier: Early-stage selection and demand forecast. Supply certainty through improved accuracy of bill of materials, fewer surprises.
j) Facilities Manager: Opportunity to influence design and operation for improved operation and maintenance.

5.5.3 *Pre-Construction Stage*

Detailed planning and procurement take place, including selecting contractors, finalizing schedules, and preparing the site. Risk assessments and coordination among stakeholders ensure readiness for the physical construction phase.

a) Client: Improved delivery confidence, earlier on-site date and reduced risk.
b) Architect and Designer: Improved multi-discipline construction model, improved predictability and fewer claims.
c) Engineer: Improved engineering design and cost modelling with reduced risks. Increased opportunity for off-site manufacturing.
d) Cost Consultant: Simpler change and review process using model. Greater clarity of specification and costs.

e) Planner and Project Manager: Improved logistics, construction scheduling and H&S planning.
f) Main Contractor: Improved collaboration with all stakeholders. Improved logistics.
g) Specialist Contractor: Increased opportunity to incorporate off-site construction.
h) Manufacturer and Supplier: Supply certainty through improved a Cost/Consultancy of information, resulting in fewer surprises. Increased opportunity for off-site manufacturing and assembly.
j) Facilities Manager: Early-stage population of Asset / Facilities Management model.

5.5.4 *Construction Stage*

This is the execution phase where the physical structure is built according to the approved design. Regular monitoring, quality control, and communication among teams are essential to stay on schedule and within budget.

a) Client: Earlier completion, reduced cost from delays and waste. Improved compliance with specification and quality.
b) Architect and Designer: Less changes to design during construction and improved compliance / design quality.
c) Engineer: Improved build quality and speed. Fewer queries / request for information (RFI). Faster commissioning and pre-populated handover details.
d) Cost Consultant: Improved visibility of costs and cash flow during construction. Fewer queries / RFI's.
e) Planner and Project Manager: Improved progress monitoring and management.
f) Main Contractor: Fewer queries / RFI's. Reduced risk of over-run. Smoother handover to Client and Asset / Facilities Manager.
g) Specialist Contractor: Smoother handover to client and Asset / Facilities Manager.
h) Manufacturer and Supplier: Improved logistics and right first time fit. Reduced need for replacement items.
j) Facilities Manager: Faster commissioning. Asset / Facilities Manager handover information pre-populated from model.

5.5.5 *Use Stage*

After project completion, ongoing maintenance ensures the structure remains functional and efficient. Facility management systems and BIM models are often used for asset tracking, repairs, and optimizing performance over the building's lifecycle.

a) Client: Better optimized and more sustainable assets / facilities with improved management and maintenance.
b) Architect and Designer: Ability to learn from whole life performance and learn from operational data and modifications.
c) Engineer: Ability to improve whole life performance and learn from operational data. Improved ability to modify to suit demands.
d) Cost Consultant: Ability to learn from operational data including whole life cost.
e) Planner and Project Manager: Reduced disruption from maintenance and modification activities.
f) Main Contractor: Reduced defects and remedial work.
g) Specialist Contractor: Opportunity for whole life service.
h) Manufacturer and Supplier: Opportunity for whole life service.

j) Facilities Manager: Facilities management system populated by supply chain and maintained by operator.

5.6 BIM Implementation

Project stakeholders produce and share structured information in a managed environment using coordinated BIM. Key Steps in BIM Implementation at the Project Level includes defining information requirements, establishing CDE, appointing key roles, developing BEP, using standardized protocols and templates, model development and coordination, validation and quality assurance, handover and asset information delivery.

5.6.1 *Defining Information Requirements*

The Appointing Party defines the Exchange Information Requirements (EIR), specifying what information is needed, when it is required, and in what format. This document sets the foundation for collaboration and aligns all stakeholders with the project's goals.

5.6.2 *Establishing a Common Data Environment (CDE)*

A CDE is implemented as a shared digital platform for storing, managing, and exchanging information. The CDE ensures that stakeholder's access and update the correct versions of data, promoting transparency and reducing errors.

5.6.3 *Appointing Key Roles*

The Appointing Party assigns a BIM Manager to oversee information management and ensure compliance with BIM standards. The Lead Appointed Party coordinates information delivery from all project participants, including Appointed Parties (designers, contractors, and suppliers).

5.6.4 *Developing a BIM Execution Plan (BEP)*

The BEP, prepared by the Lead Appointed Party, outlines how BIM processes will be implemented on the project. It includes roles and responsibilities, software workflows, model production methods, and data exchange protocols.

5.6.5 *Using Standardized Protocols and Templates*

Adhering to national BIM guidelines and standards ensures consistency in information exchange and model delivery. Standard templates for EIR, BEP, and model progression are used to streamline processes.

5.6.6 *Model Development and Coordination*

Models are created and updated according to defined LOD. Regular clash detection and coordination reviews ensure that models from different disciplines integrate seamlessly.

5.6.7 *Validation and Quality Assurance*

The Information Manager or BIM Manager conducts checks to ensure compliance with EIRs and accuracy of the data. This process minimizes risks and ensures that information is reliable for decision-making.

5.6.8 *Handover and Asset Information Delivery*

At the project's completion, the BIM models and associated data are handed over in accordance with the Asset Information Requirements (AIR). The handover ensures that operational teams have accurate and structured information for asset management and facilities maintenance.

By following these principles, BIM implementation enhances project delivery, reduces waste, and supports long-term asset management, aligning with the goals of public and private sector construction projects.

5.7 Generating BIM

BIM model matures during the project life cycle and is measured as Level of Development (LOD). LOD includes graphical, non-graphical and documentation data. The Level of Development (LOD) in BIM is a framework that combines both the Level of Detail (LOD-d), which refers to the graphical representation of a model element, and the Level of Information (LOD-i), which addresses the non-graphical data associated with that element. Together, these components define the completeness and reliability of the information embedded in a BIM model at various stages of the project lifecycle. For instance, at lower levels of development (for example, LOD 100), the model element may have basic geometry and conceptual data, whereas at higher levels (for example, LOD 400 or LOD 500), the geometry becomes highly detailed, and the associated information is precise, actionable, and suitable for construction or facilities management. This dual focus ensures that stakeholders can make informed decisions, coordinate effectively, and achieve accurate project outcomes. By aligning expectations across disciplines, the LOD concept promotes clarity and efficiency throughout the design, construction, and operational phases (*see* Table 1).

LOD is measured in the scale of LOD 100, 200, 300, 350, 400, 500 and 500+.

a) LOD 100: Conceptual

Represents a high-level, conceptual model. Elements are graphically represented with generic shapes or symbols, indicating their approximate size, location, and orientation. Non-geometric data may include overall project requirements, volumes, and areas.

b) LOD 200: Approximate Geometry

Elements are modelled with approximate geometry that may include recognizable shapes, sizes, and locations. Elements are not detailed but are distinguishable from each other. Non-geometric data is more specific than LOD 100, providing information such as material types or system roles.

c) LOD 300: Precise Geometry

Elements are modelled with precise geometry and specific dimensions. The element's position, size, shape, and orientation are accurate and coordinate able within the model. The model is detailed enough for coordination among disciplines and serves as a basis for detailed design and documentation.

d) LOD 350: Detailed Geometry with Connections

Includes the detail and accuracy of LOD 300, but with the addition of connections between elements. Elements are modelled with sufficient detail to show how they interface with other systems or components. Often used for trade coordination and clash detection.

e) LOD 400: Fabrication-Ready

Represents elements with sufficient detail for fabrication and assembly. Includes specific geometry, exact dimensions, material specifications, and detailed connections. The model supports construction and prefabrication workflows and is suitable for shop drawings.

f) LOD 500: As-Built

Represents the final, constructed state of the project. Geometry and information reflect the actual field conditions after construction is complete. Includes precise dimensions, materials, and locations, along with comprehensive operational and maintenance data. These LOD definitions help align stakeholders on expectations for model development and data richness at each project stage, ensuring effective collaboration.

Table 1 Generating BIM
(*Clause* 5.7)

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	**Category 1: Existing conditions modelling**			**Description:** Existing conditions modelling supports the aggregation and use of existing data for project modelling, studies, and options modelling.						
ii)	1.1	Project site modelling and Infrastructure modelling	An existing ground surface model of the project site and any occupying or relevant structures and utilities affecting the project	Authoring, integrating, Collaboration, Scanning, Surveying	Laser Scanner/ LIDAR, Drones, Global Navigation Satellite System (GNSS)/ Satellites, Ground-penetrating radar (GPR), Total Stations, High-performance Workstations	BIM Specialist – Reality capture, BIM Modeller - ASMEP (Architectural, Structural, Mechanical, Electrical, and Plumbing), BIM Coordinator and Manager	Stage 0 – Strategic definition, Stage 1 – Preparation and brief	LOD 200 – Generic site element modelling, LOD 300 – Accurate for cut, fill, and volume estimations	Design models, Federated models in IFC or BCF format	Computer – aided design (CAD) or Geographic information system (GIS) drawings, Google Earth photos, and scans
iii)	1.2	Surrounding site modelling	Includes the area, Buildings, and infrastructure (roads, bridges, railroad, subways,	Authoring, integrating, Collaboration, Scanning, Surveying.	Laser Scanner/LIDAR, Drones (UAVs), GNSS/Satellites, Total Stations, High-	BIM Specialist – Reality capture, BIM Modeller-ASMEP, BIM Coordinator and Manager	Stage 0 – Strategic definition, Stage 1 – Preparation and brief	LOD 100 - 200: CAD with 3D overlay, Google Earth with 3D overlay, photographs	BIM model integrated with project site model	Project Site Model, CAD or GIS drawings

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			streetcar lines) adjacent to the project site necessary for project analysis, review, or decision support		performance Workstations					
iv)	1.3	Existing conditions – Laser scanning	3D laser scanning (based upon approved survey control points) produces dimensionally accurate and detailed 3D point clouds (PC) of existing facilities and assets	Authoring, integrating, Collaboration, Scanning, Surveying	Laser Scanner/LIDAR, Drones (UAVs), GNSS/Satellites, Total Stations, High-performance Workstations	BIM Specialist – Reality capture, BIM Modeller, BIM Coordinator and Manager	Stage 0 – Strategic definition	LOD 100 – 200: CAD with 3D overlay, Google Earth with 3D overlay, photographs and Sketch-Up	3D point cloud, BIM(s) as specified in the BEP, Design models, Federated models in IFC or BCF format	CAD or GIS drawings, Google Earth photos, and scans
v)	1.4	Existing conditions – Interiors modelling	A spatially accurate model of existing spaces, building system components,	Surveying, Authoring, visualization	Laser Scanner/LIDAR, 360° Cameras, High-performance Workstations, Robots	BIM Specialist – Reality capture, BIM Modeller-Interior design, BIM Coordinator and Manager	Stage 0 – Strategic Definition, Stage 1 – Preparation and Brief	Assets and spaces are typically LOD 300	Design models in IFC format, QTO reports, COBie format, and source point cloud as backup for model validity	CAD Drawings

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			and equipment							
vi)	1.5	Geo-technical modelling	A visual, dimensionally accurate model of the geo-technical analysis report supporting project scope and requirements	Authoring, Federation, Surveying, Scanning	Laser Scanner/LIDAR, Drones (UAVs), GNSS/Satellites, Total Stations, High-performance Workstations	BIM Specialist – Reality capture, BIM Modeller-Civil, BIM Coordinator and Manager	Stage 0 – Strategic definition, Stage 1 – Preparation and brief	LOD 100 – 200: CAD with 3D overlay, Google Earth with 3D overlay, photographs and Sketch-Up	Geotechnical model integrated with project site model	Geo-technical data, CAD and GIS drawings
vii)	1.6	Site modelling – Horizontal construction	Roadways, raised bridges and walkways, and transportation structures such as pedestrian tunnels are all examples of horizontal modelling needs	Authoring, Federation, Visualization	Laser Scanner/LIDAR, Drones (UAVs), GNSS/Satellites, Total Stations, High-performance Workstations	BIM Specialist – Reality capture, BIM Modeller-ASMEP, BIM Coordinator and Manager	Stage 0 – Strategic definition, Stage 1 – Preparation and brief	Model Elements General description and LOD 200 - 350, Horizontal Structures LOD 300 – 350	3D Site Model, utilities in DWG format, and Structural design model in IFC format, Federated model may be linked to site model	A combination of CAD with 3D overlay, Google Earth with 3D overlay, photographs and Sketch-up
viii)	**Category 2: Design and Building System Authoring**		**Description:** Design and Building System Authoring supports the modelling of Individual disciplines which are federated to create the Design Intent model of the final design solution.							

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
ix)	2.1	Architectural modelling	This model is used to explore design options, and serves as a base model for the federated design intent model, design analysis, and other BIM Uses	Design, Authoring, Collaboration, Integrating, Visualization / Rendering.	Can be visualized using Augmented reality (AR)/Virtual reality (VR) Headsets or devices such as Tablets, High-performance Workstations	Designers and BIM Modellers – Architecture, BIM Coordinator - Design	Stage 2 – Concept Design	LOD 200 – 300	Design model, federated model in IFC/BCF format for handover, used as basis for record (As-built) model	CAD Drawings
x)	2.2	Space, Accessibility, and Circulation Requirements Modelling	To model space, circulation areas, and accessibility using accessibility standards, consistent modelling methods	Design, Authoring, Collaboration, Integrating, Checking, commenting.	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	Designers and BIM Modellers – Architecture, BIM Coordinator - Design	Stage 2 – Concept Design	LOD 200 – 300	Space views and space reports for design meetings and communication during design development	CAD Drawings, Specifications and Standards
xi)	2.3	Structural Modelling	A model of the structural system of an existing or proposed design	Design, Authoring, Collaboration, Integrating, Reviewing, Checking.	Can be visualized using AR/VR Headsets or devices such as Tablets, High-	Designers and BIM Modellers – Structural, BIM Coordinator - Design	Stage 3 - Developed Design	LOD 300	Structural discipline model, shop drawings integrated into the structural model.	Structural Design Data, CAD Drawings

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
					performance Workstations					
xii)	2.4	HVAC Mechanical Systems	A model of MEP (mechanical, electrical and plumbing) system for decision support and analysis, made ready for detailing and fabrication	Design, Authoring, Collaboration, Integrating, Reviewing, Checking.	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	Designers and BIM Modellers – MEP, BIM Coordinator - Design	Stage 3 – Developed Design	LOD 200 – Generic elements, LOD 300 – Detailed elements, LOD 400 – LOD 400 for field installation	Structural discipline model, clash avoidance among Architectural, Structural, and HVAC	MEP Design Data, CAD Drawings
xiii)	2.5	Plumbing and Fire Protection	A model of Plumbing and Fire Protection system sufficient for shop modelling and fabrication	Design, Authoring, Collaboration, Integrating, Reviewing, Checking.	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	Designers and BIM Modellers – Plumbing and Fire Protection, BIM Coordinator - Design	Stage 2 – Concept Design	LOD 200 – 500 for As-built (Record) Model	Discipline model, COBie data and commissioning information, construction drawings to Architect/Engineer	CAD Drawings, Specifications and Standards
xiv)	2.6	Electrical Alarm Systems	A model or part of the electrical model, the primary components of the	Design, Authoring, Collaboration, Integrating, Reviewing, Checking.	Can be visualised using AR/VR Headsets or devices such as Tablets, High-	Designers and BIM Modellers – IT and Security, BIM Coordinator - Design	Stage 3 – Developed Design	LOD 200 – 300	Deliverables include discipline models, distribution panel schedules and	CAD Drawings, Specifications and Standards

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			electrical, lighting, alarm systems and building automation systems (BAS) controls		performance Workstations				other equipment schedules, sensor locations, COBie data	
xv)	2.7	Interiors	Modelling of interior design options, materials and finishes, systems, signage, and daylighting.	Design, Authoring, Collaboration, Integrating, Visualization / Rendering	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	Designers and BIM Modellers – ID, BIM Coordinator - Design	Stage 3 – Developed Design	LOD 300	Include renderings and model views as requested for design review	BIM Architecture Model
xvi)	2.8	Tenant Build-Out	Tenant projects include simple kiosks, office spaces, technical laboratory spaces, and other specialized-function spaces.	Design, Authoring, Collaboration, Integrating, Reviewing, Checking, Visualization / Rendering	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	Designers and BIM Modellers – ASMEP, BIM Coordinator - Design	Stage 3 – Developed Design	LOD 300	Include renderings and model views as requested for design review	BIM Architecture Model

5.8 Using the Generated BIM

Using the generated BIM can be strategized by each project team. Project team here refers to design, construction and operations team. Each project stakeholder or team shall use the generated BIM in a manner that facilitates their work and contributes to qualitative and quantitative benefits during the capital expenditure or operational expenditure phase of the project. It is important that project stakeholders from design, construction and operation teams are possessing the necessary BIM skills and competencies depending on the type and complexity of the project.

To realize benefits of using generated BIM within the project execution process, it is essential to perform a set of BIM Uses. BIM Uses such as 2D documentation, 3D detailing, BIM/GIS overlapping, energy simulation, sustainability analysis and whole life cycle analysis can occur in six to seven stages of the project lifecycle (PLC). Few of these BIM uses are fundamental for the delivery of BIM projects. The primary BIM uses are design authoring, 2D documentation, clash detection, cost estimation, structural analysis, construction planning, BIM for facility management integration, among others. Moreover, for some of these BIM uses to be executed, it is essential to have other sets of BIM uses executed as a prerequisite. The criticality of any BIM use depends on the project type and its complexity. Each project type demands a different set of BIM uses as critical ones. It is a prerequisite to understand the project type, project goals, and BIM uses relationships to choose the right set of BIM uses for any project delivery (*see* Table 2).

Table 2 Using the Generated BIM
(*Clause* 5.8)

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
i)	**Category 3: Analysis and reporting**			**Description:** A major benefit of BIM is the ability to analyse the model for performance, design conformance, and to run reports of critical design information as the model changes.						
ii)	3.1	Area and Space Program Validation	The BIM file, specifically spaces and bounding elements, including floors and stories, is analysed using model checking software	Authoring, Reviewing, Checking	High-performance Workstations	Designers and BIM Modellers – Architecture, BIM Coordinator - Design	Stage 2 – Concept Design	LOD 200 – 300	Space area model with minimum space attributes	BIM Architecture Model
iii)	3.2	Design Options	Model with design options supporting the project program requirements	Design, Authoring, Reviewing, Visualization / Rendering.	BIM Experience Centre, High-performance Workstations	Designers and BIM Modellers – Architecture, BIM Manager and Coordinator – Design, BIM Specialist – Immersive Experience	Stage 2 – Concept Design	LOD 100 – 300	Structural discipline model, Clash avoidance between Architectural, Structural, and HVAC, Equipment lists	BIM Architecture Model

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
iv)	3.3	Model Checking – Program Compliance	Model checking is a rules-based activity that automates model review for design program, modelling quality, data, and some code conformance	Reviewing, Checking, Commenting, Viewing.	High-performance Workstations	BIM Coordinator – Design and Construction, BIM Manager	Stage 3 – Developed design	LOD 300	Model confirming to Codes and set rules	Populated BIM Model, Standards and Specifications
v)	3.4	Clash Avoidance and Detection	Primary method to minimize interferences between building elements using “clash detection” software	Integrating, Collaboration, Reviewing, Checking, Commenting	High-performance Workstations	BIM Manager and Coordinator – Design	Stage 3 – Developed design	LOD 300	Clash report between different disciplines Architectural, MEP	Populated BIM Model with Architecture, MEP, Structural elements
vi)	3.5	Structural Analysis	Model based analysis of structural design to determine fitness for use	Analysis, Authoring.	High-performance Workstations	BIM modeller – Structural, BIM Coordinator - Design	Stage 3 – Developed Design	LOD 300	Structural analysis report and graphics for design reviews	Structural Design Data, CAD Drawings

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
vii)	3.6	Equipment and Maintenance Clear Space	This modelling covers major equipment and elements requiring defined access or maintenance space	Authoring, Integrating, Reviewing, Checking.	High-performance Workstations	BIM Modeller – MEP, BIM Coordinator – Design, Operations	Stage 3 – Developed Design	LOD 400	BIM-based review with Facility management	Populated BIM Model, Standards and Specifications
viii)	3.7	Budgetary Costing	Budgetary Cost uses BIM spaces, major building elements with historic square foot costing data, project type, region, and construction type, to calculate budgetary estimates.	Authoring, Costing, Tracking, Viewing.	High-performance Workstations	BIM Specialist – 4D BIM, 5D BIM, BIM Manager – Design, Construction	Stage 2 – Concept Design	LOD 200 – 300	Periodic costing reports for design options	Populated BIM Model, Cost data
ix)	3.8	Quantity Take-Off (QTO)	QTO serves as the basis for estimating. It provides professional estimators with quantities used, rather	Authoring, Costing, Integrating	High-performance Workstations	BIM Specialist – 4D BIM, 5D BIM, BIM Manager – Design, Construction	Stage 3 – Developed Design	LOD 200 – 350	Provide in “scheduled” format (grid or spreadsheet), quantity listings for all elements	Populated BIM Model

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			than quantities to be purchased							
x)	**Category 4: Sustainability, Energy, Green Certification**		**Description:** BIM analysis to help achieve sustainable, resilience, and energy efficient designs on its projects							
xi)	4.1	Energy Modelling, Sun Studies, Day Lighting	BIM Model is analysed to improve day lighting in design, to understand sun shading needs and the balance between daylight and artificial lights to support space usefulness	Analysis, Viewing.	High-performance Workstations	BIM Specialist – Lean and Green, BIM modeller – Architecture, BIM coordinator - Design	Stage 2 – Concept Design	LOD 200	Calculations, data, and visualization of the study. Analysis to be used in BIM-based reviews, and design option activities	BIM Architecture Model
xi)	4.2	Existing Building – Rapid Energy Modelling	Rapid Energy Modelling (REM) is a streamlined process for simplified simulation that quickly and with minimal data from	Authoring, Analysis, Viewing.	High-performance Workstations	BIM Specialist – Lean and Green, BIM modeller – Architecture, BIM coordinator - Design	Stage 2 – Concept Design	LOD 200	Energy analysis report from existing building conditions	Building Conditions, Architecture model

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			existing building conditions develops an energy analysis							
xii)	4.3	Mechanical Analysis	Virtual testing and balancing of the design model to support sustainable building systems design and analysis, calculate native heating and cooling analysis that is built into the MEP software	Authoring, Analysis, Viewing	High-performance Workstations	BIM Specialist – Lean and Green, BIM modeller – MEP, BIM coordinator - Design	Stage 3 – Developed Design	LOD 300	Native heating and cooling analysis report exported to an external analysis application	Federated MEP Model, Meteorological data
xiii)	4.4	Sustainability Credit and Certification Reporting	BIM to identify, quantify, and cross-reference materials supporting sustainability credits	Authoring, Analysis, Checking, Viewing.	High-performance Workstations	BIM Specialist – Lean and Green, BIM Manager and Coordinator - Design	Stage 2 – Concept Design	LOD 200	Images, documentation, and reports as evidence of conformance for	Federated BIM Model, sustainability certification specifications and Requirements

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
									sustainability certification	
xiv)	4.5	Lighting Analysis	Use Case has two objectives: sustainability compliance and energy performance and comfort	Authoring, Analysis, Viewing	High-performance Workstations	BIM Specialist – Lean and Green, BIM coordinator - Design	Stage 2 – Concept Design	LOD 200	Images, documentation, and reports as evidence of conformance for sustainability certification	Federated BIM Model, sustainability certification specifications and Requirements
xv)	4.6	Systems Analysis	BIM is used to capture the building geometry and characteristics needed to conduct aspects of energy performance analysis and support contracting processes	Authoring, Analysis, Viewing.	High-performance Workstations	BIM Specialist – Lean and Green, BIM modeller – MEP, BIM coordinator - Design	Stage 2 - Concept Design	LOD 200	A series of analysis reports identifying the options and the optimum solution for energy reduction	Federated BIM Model, Building Performance Requirements

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
xvi)	**Category 5: Design, constructability reviews and coordination**			**Description:** BIM enables the design and construction teams to work in a Lean manner to maximize BIM use, communication, and coordination.						
xvii)	5.1	BIM Based Progress Meetings, Reviews – "Big Room"	To minimize misinformation between team members, to reduce paper-based communication, and to focus attention on design decisions	Authoring, Integrating, Collaboration, Reviewing, Commenting, Viewing.	Can be visualised using AR/VR Headsets or devices such as iPads/Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	BIM Managers and Coordinators – Design, Construction and Operations, BIM Specialist – Immersive Experience.	Stage 4 – Technical Design	LOD 200 – 300	Design reviews, Constructability reviews, Shop drawings, Construction documents, Performance review reports	Federated BIM Models corresponding to Meeting requirements
xviii)	5.2	Digital Details, Mock-ups	Design Coordination Reviews, Constructability Reviews, Shop Drawings, Construction Documents, Energy and Performance Reviews, Change Management Reports, Cost Estimates,	Authoring, Ordering, Manufacturing, Design	Can be visualized using AR/VR Headsets or devices such as Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	BIM Modellers – ASMEP, BIM Coordinator and Manager – Design and Construction	Stage 4 – Technical Design	LOD 200 – 300	Images, views, sub-models, integrated model sections, per the mock-up creation, and views to be integrated into the construction drawings	Federated BIM Models corresponding to Mock ups

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			Value Analysis Reports							
xix)	5.3	Scheduling – 4D Modelling and Logistics	Construction coordination model supporting Look-Ahead, construction phasing, construction material movement, labour sequencing, site planning for material delivery, loading/unloading, staging, and storage	Authoring, Planning, Tracking, Progress reviewing, Viewing.	Can be visualised using AR/VR Headsets or devices such as Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	BIM Specialist – 4D BIM, VDC Simulations, BIM Coordination and Manager - Construction	Stage 5 – Construction	LOD 300	Updated 4D models as the project progresses, with updating, reporting, and delivery as set in BEP	Federated BIM Models corresponding to Scope of work
xx)	5.4	Site Safety Review	Integrating the project site logistics, materials and equipment use, vehicles, with load and	Authoring, VDC, Viewing, Training	Can be visualised using AR/VR Headsets or devices such as Tablets. Will need	BIM Specialist – Safety and Risk, VDC simulations, BIM Manager and	Stage 5 – Construction	LOD 300	Deliverables include site views, animations, construction and logistics plans	BIM Models with site logistics

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			delivery planning schedule data with BIM provides a means to see, prevent, and resolve conflicts.		AV/Projector setups for BigRooms, High-performance Workstations	Coordinator – Construction			in PDF format as the project progresses security model, delivery schedules, and schedule updates	
xxi)	5.5	In Field – Construction Layout	BIM is used as a basis for laser guided field layout of walls and building elements. BIM supports better construction layout.	Surveying, Scanning, Viewing.	3D Scanner - LIDAR, can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	BIM Coordinator – Design and Construction, BIM Manager – Construction	Stage 4 – Technical Design	LOD 300	XYZ survey/layout point files for exchange with field layout equipment	Project features must be modelled to support this Use Case
xxii)	5.6	Laser Scanning – Construction Phase	3D laser scanning performed during construction captures as-built work. This aids the team in change management, captures	Scanning, Surveying, Authoring, Viewing.	3D Scanner - LIDAR, can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	BIM Specialist – Reality capture, BIM Modellers – ASMEP, BIM Coordinator – Design and Construction, BIM Manager - Construction	Stage 5 – Construction	LOD 300	Registered/ rotated/ elevated 3D point clouds conforming to the defined coordinate system	Coordinates for survey points, CAD Drawings

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			newly built conditions prior to being covered and closed to view, and later will aid facilities operations in reliably locating systems components with a high degree of accuracy							
xxiii)	5.7	Pre-Fabrication Building Components	BIM Use Case includes modelling the proposed building components with a focus on visualizing and simulating the logistics of their placement in a new or existing building, as well as the	Authoring, Ordering, manufacturing, Design, Viewing	Can be visualized using AR/VR Headsets or devices such as Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	BIM Specialist – Digital fabrication, BIM Manager and Coordinator – Design and Construction	Stage 4 – Technical Design	LOD 400	Deliverables include schematics and animation sequences of prefabricated building components being transported, placed onsite, and installed	Federated BIM Model with site logistics

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			logistics of maintenance, repair and eventual replacement in situ.							
xxiv)	**Category 6: Documentation, Drawing and Specs**		**Description:** BIM enables drawings and construction sets to be derived from the model. The following BIM Uses support BIM use for more coordinated documentation during design and for record models at project turnover.							
xxv)	6.1	Construction Drawing Production	Construction Documents (CDs) are derived from the model. Views are automatically generated in the BIM file by the authoring software.	Authoring, Viewing, Collaboration.	High-performance Workstations	BIM Modellers – ASMEP, BIM Coordinator - Design	Stage 5 – Construction	LOD 300	Deliverables will be as per Drawing and Publishing requirements in the BIM Guidelines	Federated BIM Models corresponding to Scope of work
xxvi)	6.2	Shop Drawing Coordination	Detailed shop drawings for fabrication and construction are derived from the discipline specific design intent model.	Authoring, ordering, manufacturing, Viewing, Collaboration.	AV/Projector setups for Big Rooms, High-performance Workstations	BIM Modellers – ASMEP, BIM Manager and Coordinator – Design and Construction	Stage 4 – Technical Design	LOD 400	Shop drawings with building elements, components, and parts according to the design intent model.	Federated BIM Models corresponding to Scope of work

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
xxvii)	6.3	AS-BUILT Models	BIM Models with AS BUILT construction Information	Authoring, Viewing, Reviewing, Commenting	Can be visualized using AR/VR Headsets or devices such as Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	BIM Specialist – Reality Capture, BIM Modellers – ASMEP, BIM Manager and Coordinator – Design, Construction and Operation	Stage 5 – Construction	LOD 500	As Built models suitable for facility management	Federated BIM Models with AS BUILT information
xxviii)	6.4	Data Normalization	Data Normalization is essentially the task of preparing data to be usable by BIM systems in a consistent manner to provide consistent reports and analyses with minimum querying effort	Classification System, Data Management, Authoring, Checking.	High-performance Workstations	BIM Coordinator - Design	Stage 4 – Technical Design	LOD 300	BIM Record model with normalized data	COBie Database

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
xxix)	6.5	AS-BUILT CAD Drawings for Handover	As-Built CAD drawings of all floor plans from the Record Model	Authoring, Viewing, Integrating.	High-performance Workstations	BIM Modellers – ASMEP, BIM Coordinator – Design, Construction and operations.	Stage 5 – Construction	LOD 500	As Built models suitable for facility management	Federated BIM Models with AS BUILT information
xxx)	**Category 7: Commissioning and Handover**		**Description:** Commissioning of the BIM itself may be required according to specifications found in the BEP							
xxxi)	7.1	Virtual Handover (Record Model)	The virtual handover (record model) is the design intent model, updated with as-built locations for building elements within the model.	Authoring, Viewing, Validating, Publishing.	Can be visualized using AR/VR Headsets or devices such as Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	BIM Specialist – Digital Twin and Building Automation, BIM Coordinator and Manager – Construction and Operations	Stage 4 – Technical Design	LOD 300	The record model contains the necessary building element updates, product, space, and Facility Management data	Federated BIM Model
xxxii)	7.2	COBie Data Set	COBie (Construction Operations Building Information Exchange) is a vendor-	Authoring, Data drops, Integrating, Checking.	High-performance Workstations	BIM Specialist – Soft-landings, BIM Coordinator and Managers – Design, Construction	Stage 4 – Technical Design	LOD 300	Based upon the agreed upon assets to be defined in COBie, the team will populate the	Object Attributes for Type, Component, System, Space, Facility

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			neutral flexible data specification that indicates how to format design and construction data so that they can be consumed by other facility software.			and Operations			COBie worksheets as per the schedule defined	
xxxiii)	7.3	Commissioning	Commissioning is a systematic process of verifying that all building systems perform interactively according to the design intent and the owner's operational needs	Authoring, Viewing, Analysis Planning, Validating, Publishing.	Can be visualized using AR/VR Headsets or devices such as Tablets. Will need AV/Projector setups for Big Rooms, High-performance Workstations	BIM Specialist – Soft-landings, BIM Coordinator and Managers – Construction and Operations	Stage 6 – Handover and Closeout	LOD 500	Record model updated with data requirements on major assets and spaces and project construction documentation supporting the commissioning process	Federated BIM Model with As Built Information
xxxiv)	7.4	Model Data Supporting Disaster Planning	BIM use and GIS data for Master Planning studies that	Authoring, Analysis, Integrating, Publishing.	High-performance Workstations	BIM Modeller – Structural, BIM Specialist – Geo-BIM, Safety and	Stage 3 – Developed Design	LOD 300 – 350	Deliverables include simulations, model views supporting	BIM Model, GIS Data

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			include considerations for disaster planning			Risk, VDC Simulations, BIM Coordinator and Manager – Construction and Operations			design options during design and master planning, assumptions, and some degree of structural analysis	
xxxv)	7.5	Model for Maintenance and Maintenance Training	The models are used during commissioning, preoccupation, and post-occupation to train staff on asset location, maintenance access, and maintenance procedures.	Authoring, Validating, Publishing, integrating, viewing.	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	BIM Specialist – Soft-landings, BIM Coordinator – trainings, BIM Coordinator and Manager – Construction and Operations	Stage 7 – In Use	LOD 500	Asset Information Model for Facility Management	Federated BIM Model with As Built Information
xxxvi)	**Category 8: Facilities and Data Integration**		**Description:** BIM may be used in the field for efficient data collection. Facilities data from the BIM model can be integrated with BAS							
xxxvii)	8.1	Assessment Models	BIM may be used in the field for efficient data collection.	Measuring, Validating, Publishing, Viewing.	Can be visualized using AR/VR Headsets or devices such as Tablets,	BIM Specialist – Digital Twin and Building Automation, BIM Coordinator	Stage 5 – Construction	LOD 300	Updated BIM models, Assessment reports, and Database for integration with	Federated BIM Models corresponding to Scope of work

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
					High-performance Workstations	and Manager - Operations			Facility Management Tools	
xxxviii)	8.2	Space Planning – Move Management	The design and space planning team will utilize BIM and intelligent objects to manage space, occupancy and use.	Authoring, Recording, Analysis Planning.	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	BIM Specialist – 4D BIM, BIM modeller – Architecture, BIM Coordinator and Manager - Operations	Stage 7 – In Use	LOD 500	IFC model	Federated BIM Model with As Built Information
xxxix)	8.3	Security	BIM can be used for security studies on public and institutional, prisons, judicial, and health care facilities.	Authoring, Analysis Planning, Measuring.	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	BIM Modeller – IT and Security, BIM Coordinator – Trainings and Construction	Stage 4 – Technical Design	LOD 500	Deliverables include model views, animations, and simulations supporting security review	Federated BIM Model with As Built Information
xl)	8.4	CMMS and CAFM Data Model Integration	BIM Models can be used for effective Computerized Maintenance Management System and	Analysis Planning, Measuring.	Can be visualised using AR/VR Headsets or devices such as Tablets, High-	BIM Specialist – Digital Twin and Building Automation, BIM Coordinator and Manager – Construction	Stage 7 – In Use	LOD 500	IFC model	Federated BIM Model with As Built Information

Sl. No.	Category	BIM Use Case	Description	Software	Equipment	People	Project Stage	LOD	Deliverables	Data
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			Facility Management		performance Workstations	and Operations				
xli)	8.5	Resiliency Modelling	Visualization and simulation can be used to support land use policies and help analyse first responder data and access prior to determining a final strategy	Authoring, Analysis Planning, Publishing.	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	BIM Specialist – Geo-BIM, VDC Simulations, BIM Manager and Coordinator - Operations	Stage 3 – Developed Design	LOD 300 – 350	Animations and Simulations for BIM and GIS, and IFC models for exploration	BIM Model, GIS Data
xlii)	8.6	Building Automation Systems (BAS) Integration	Integration of BIM graphics (2D and 3D) as spatial location points for building system sensor data. This is used for real-time displays of system activities.	Measuring, Recording, Validating, Publishing.	Can be visualized using AR/VR Headsets or devices such as Tablets, High-performance Workstations	BIM Specialist – Digital Twin and Building Automation, BIM Manager and Coordinator - Operations	Stage 7 – In Use	LOD 500	IFC model	Federated BIM Model with As Built Information

5.9 Generic Names for BIM Software Capability – *See* Annex H

5.10 BIM and Digitalization Roles – *See* Annex J

5.11 Hardware and Equipment in BIM Implementation – *See* Annex K

5.12 Impacts and Benefits of Generating and Using BIM – *See* Annex M

6 PERMIT TO WORK SYSTEM

6.1 General

The permit to work (PTW) system is a formal procedure established to ensure that hazardous activities within building environments are carried out safely. It regulates the execution of high-risk tasks, ensuring that safety measures are taken before and during work. The PTW system identifies risks, specifies necessary precautions, and controls activities in areas where potential hazards are present. For detailed guidelines, reference shall be made to good practice [7(17)].

6.2 Scope of Application

6.2.1 The permit to work system applies to the following activities, which pose significant risks to personnel and the building environment:

a) *Cold Work Permits* – For non-heat generating tasks such as routine maintenance, inspection, and equipment repair. Good practice [7(17)] shall be followed to issue cold work permit.

b) *Hot Work Permits* – For activities that produce heat or sparks, including welding, cutting, grinding, and fire-hazardous operations. Good practice [7(17)] shall be followed to issue hot work permit.

c) *Confined Space Entry Permits* – For entry into confined spaces with restricted ventilation, or where toxic gases or oxygen deficiency may pose a danger (for example, building basements, heating, ventilation, and air conditioning systems). Good practice [7(17)] shall be followed to issue confined space entry permit.

d) *Excavation Permits* – For activities involving excavation deeper than 300 mm within building premises. Good practice [7(17)] shall be followed to issue excavation permit.

e) *Electrical Work Permits* – For tasks involving electrical systems, ensuring proper energy isolation. Good practice [7(17)] shall be followed to issue electrical work permit.

f) *Work at Height Permits* – For activities conducted above 1.8 m from ground level without permanent guardrails. Good practice [7(17)] shall be followed to issue working at height permit.

6.2.2 In the dynamic environment of the construction industry, managing work permits can be challenging. Digital permit-to-work features simplify this process, ensuring efficiency and safety for all involved parties.

6.3 Permit Issuance and Execution

6.3.1 *Request and Risk Assessment*

A permit shall be requested by the executor or issuer before the commencement of work. A joint risk assessment shall be conducted by the issuer and executor to identify hazards and determine specific safety measures, such as isolating energy sources, gas testing (if applicable), and ensuring the availability of personal protective equipment.

6.3.2 *Permit Issuance*

The permit shall be issued by an authorized issuer, typically the shift in-charge, after conducting a joint risk assessment with the acceptor or executor. The permit shall clearly outline the nature and scope of the work, associated risks, necessary safety measures, and personal protective equipment to be used during the job.

The work permit shall be prepared in triplicate. The first copy shall be displayed at the job location for awareness and audit purposes. The second copy shall be retained by the issuer for record-keeping, and the third copy shall be provided to the safety department. Before issuing the permit, the issuer shall ensure that all equipment preparation, safety checks, and isolation procedures are completed. The permit shall only be issued after verifying that all safety protocols are in place. Any special safety precautions, such as fire protection for hot work or gas testing for confined space entry, shall be specified in the permit as agreed upon during the risk assessment.

6.3.3 *Permit Execution*

The executor shall ensure that all safety protocols outlined in the permit are strictly followed. Work shall be continuously monitored to ensure compliance with safety conditions. Any deviation or unforeseen hazard shall result in the suspension of work until the risk is mitigated.

6.3.4 Permit Closure

Upon completion of the work, the following steps shall be taken to ensure the proper closure of the permit to work:

a) The receiver shall certify that the work has been completed or stopped and that the work area has been cleared of all tools, materials, and personnel.

b) The issuer shall verify that the job has been completed satisfactorily and that the area is safe from any hazards.

c) The closure shall be documented by recording the date and time of completion on the permit.

d) All signing authorities for approval shall sign the permit for closure of the permit.

e) The original permit shall be returned to the issuing authority, who shall retain it for a minimum period of 30 days for record-keeping purposes.

6.4 Responsibilities of Personnel

6.4.1 *Issuer*

The issuer shall:

a) Control the permit to work process and ensure that all safety measures are taken before authorizing work,

b) Ensure that personnel involved in the task are trained and aware of the risks and safety requirements, and

c) Ensure regular audits of permits to confirm compliance with safety protocols.

6.4.2 *Executor*

The executor shall:

a) Be responsible for the safe execution of the job,

b) Ensure that all required safety measures, including the use of personal protective equipment, are adhered to during the task, and

c) Communicate with the issuer and report any deviations or hazards encountered during the work.

6.5 Risk Mitigation and Safety Measures

6.5.1 *Risk Assessment*

Before commencing any work, a comprehensive risk assessment shall be conducted by the issuer and receiver to identify potential hazards associated with the planned task. The assessment shall outline residual hazards and the necessary safety precautions to mitigate these risks.

6.5.2 *Safety Precautions*

The following safety measures shall be implemented based on the results of the risk assessment:

a) The work area shall be inspected to ensure it is free from hazards such as combustible materials, flammable gases, and other substances that may pose a risk during the work.

b) Barricades or warning signs shall be placed around the work area to restrict access to unauthorized personnel.

c) Adequate fire protection measures, including portable fire extinguishers and fire hoses, shall be made available in the work area where applicable.

d) Tools and equipment used shall be suitable for the task and shall be inspected for defects prior to use. Non-sparking tools shall be employed in flammable areas.

6.5.3 *Personal Protective Equipment*

Personal protective equipment shall be specified in the permit based on the nature of the work. This may include helmets, gloves, safety shoes, face shields, and specialized equipment, as required by the risk assessment.

6.5.4 *Emergency Procedures*

Emergency procedures shall be established and communicated to all personnel involved in the task. This includes knowing the location of the nearest fire alarm, first aid station, and emergency exits. A trained standby person shall be present in high-risk situations to assist in case of an emergency.

6.5.5 *Equipment and Isolation*

Energy sources associated with the work shall be positively isolated before starting.

6.6 Permit Validity and Renewal

6.6.1 *Validity*

Permits shall be valid for a maximum of seven days. If work is not completed within this period, the permit shall either be revalidated or renewed. For long-term work, such as during major building renovations, a new permit shall be issued after the original permit expires.

6.6.2 *Revalidation and Renewal*

If the scope of work extends beyond the original permit's validity or if working conditions change, the issuer and executor shall jointly inspect the site and decide whether to revalidate or issue a new permit. Renewals shall be recorded, and gas tests repeated where applicable.

6.7 Audits and Compliance

The Permit to Work system shall undergo regular audits to ensure compliance with safety regulations. Authorized personnel shall review permit documentation, observe work conditions, and verify adherence to all safety measures outlined in the permit. Non-compliance can result in the cancellation of the permit.

SECTION 2 CONSTRUCTION PLANNING AND SITE MANAGEMENT

7 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 time constraints, 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 Preconstruction Phase

7.1.1 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.

7.1.2 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.

7.1.3 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. To mitigate noise impact on the surrounding neighbourhood during construction, reference shall be made to Part 8 'Building services, Section 4, Acoustics, Sound Insulation and Noise Control' of the Code.

7.1.4 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.

7.1.5 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.

7.1.6 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.

7.1.7 Construction practices in disaster prone areas need specific planning. The type of construction, use of materials, construction techniques require special considerations in such areas.

7.1.8 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, suiting the site conditions, the design and field operations should be adapted or redefined based on considerations, such as the following:

a) Site layout which enables accessibility in adverse weather.
b) Adequate protected storage for weather sensitive materials/equipment.
c) Protection to personnel from extreme hot/cold conditions.
d) Scheduling to allow maximization of outdoor activities during fair weather conditions.
e) 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).
f) Adequate lighting for shorter days in winter/night work.
g) Design for early enclosure.

7.2 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 (*see also* **4.2.3.2.3**).

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 favourable 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. Source of funding of the project and its timeliness with reference to requirement of cash flow should also merit consideration. 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.

7.3 Construction Phase

7.3.1 *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.

7.3.2 *Site Management*

7.3.2.1 *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 (*see* **16**) with use of non-combustible materials as far as possible including emergency medical aids.
h) Roads for vehicular movement with effective drainage plan.
j) Construction safety with emergency access and evacuations and security measures.
k) Fabrication yards for reinforcement assembly, concrete precasting and shuttering materials.
m) Fencing, barricades and signages.

7.3.2.2 *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.

7.3.2.3 *Access to the upper floors during construction*

In all buildings over two storeys 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.

7.3.2.4 *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 **12** of Part 8 'Building Services, Section 2 Electrical and Allied Installations' of the Code.

7.3.3 *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:

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

7.3.4 *Canteen Facility at Site*

A canteen facility should be provided at construction sites to ensure workers have convenient access to nutritious meals and clean drinking water, essential for maintaining health, energy, and productivity. The facility shall offer a designated, hygienic space for eating and resting, preventing workers from consuming food in unsafe areas. It should provide affordable, balanced meal options that cater to diverse dietary needs, promoting worker satisfaction and reducing fatigue-related risks. The facility may include additional amenities to enhance comfort, and its location shall be planned to minimize the need for workers to leave the site during breaks, thereby supporting time management and fostering a safe and supportive work environment.

7.4 Emergency Response and Disaster Management Plan at Construction Sites

7.4.1 *General*

Every construction site, regardless of size, scale, or location, shall implement an emergency response and disaster management plan (ERP) to protect workers, visitors, and the public. The ERP shall be structured to address common construction risks such as falls, fires, accidents, and equipment failure. The plan shall be tailored to the specific nature of the site, ensuring that risks are minimized and that emergency measures are in place to handle unforeseen incidents.

7.4.2 *Hazard Identification and Risk Assessment*

A hazard identification process and a thorough risk assessment shall be mandatory for all construction sites. The assessment should cover common site hazards such as machinery use, scaffolding, fall protection, material handling, and fire safety. This risk assessment shall be updated periodically as construction progresses or when new risks emerge.

7.4.3 *Emergency Response Plan Development*

The ERP shall include the following core elements:

a) Clearly marked evacuation routes and safe assembly points.
b) Communication protocols and emergency contact details.
c) Roles and responsibilities of workers and site management during emergencies.
d) First aid provisions, fire-fighting procedures, and accident containment strategies.
e) Coordination mechanisms with nearby medical facilities and local fire departments.

Every construction site shall conduct regular emergency drills to ensure that all workers are familiar with evacuation procedures and are aware of their roles in the event of an emergency.

7.4.4 *Site Access and Emergency Equipment*

Emergency access routes and exits shall be designed to ensure unobstructed paths for rescue and fire services. Construction sites shall be equipped with the following:

a) Fire extinguishers and fire suppression systems.
b) First aid kits, stretchers, and first responders trained in basic medical care.
c) Emergency alarms and communication devices installed at strategic locations.
d) Personal protective equipment (PPE) for fire, falls, and other potential hazards.

Routine inspection of this equipment shall be conducted to ensure proper functionality at all times.

7.4.5 *Training and Worker Safety*

All workers shall receive basic safety training covering fire safety, hazard recognition, first aid, and emergency procedures. For large construction sites, a trained emergency response team (ERT) shall be available on-site, capable of handling fire outbreaks, medical emergencies, and evacuation management. Regular safety drills shall be organized to ensure that all workers can respond efficiently during emergencies.

7.4.6 *Post-Emergency Protocols*

After any emergency, construction sites shall conduct a post-incident evaluation to identify lapses in the response and areas for improvement. Before resuming work, the site shall undergo safety inspections to confirm the structural integrity and the safety of the work area. The recovery plan should also include counselling for workers affected by the emergency.

7.4.7 *Special Provisions for Hazard-Prone Construction Sites*

Construction sites located in hazard-prone areas, such as those vulnerable to floods, earthquakes, landslides, or areas involving high-risk materials, shall have additional disaster management provisions. Hazard-specific risk assessments shall be carried out, and the ERP shall be modified to handle specific risks associated with the location.

7.4.7.1 *Site-specific risk assessments*

Hazard-prone construction sites shall undergo specialized risk assessments, focusing on:

a) Geotechnical and environmental risks like landslides, floods, and seismic activity.
b) Construction activities involving hazardous materials like chemicals, gas, or explosives.
c) Large-scale public interaction zones where risk to public safety may be heightened.

The results of these assessments shall directly inform the development of the emergency response plan, ensuring that hazard-specific risks are managed and mitigated effectively.

7.4.7.2 *Specialized disaster response*

For sites in disaster-prone areas, the ERP shall include provisions for:

a) Early warning systems and alarms for events like floods or earthquakes.
b) Coordination with local disaster management authorities for prompt evacuation and rescue.
c) Deployment of specialized equipment for dealing with hazardous material spills or structural collapses.

Wherever possible, the emergency plan shall incorporate advanced measures such as satellite communication and drone surveillance for monitoring the site during disaster conditions. Construction projects involving hazardous materials should also maintain a separate hazardous material containment plan in conjunction with the overall ERP.

7.4.7.3 *Worker training and coordination*

Workers on hazard-prone sites shall receive specialized training for responding to site-specific risks, such as dealing with hazardous materials, responding to floods or seismic activity, and managing large-scale evacuations. These sites shall also establish communication protocols with local emergency services and may form a mutual aid agreement with neighbouring projects to enhance response capabilities.

7.4.7.4 *Coordination with disaster management agencies*

For hazard-prone sites, a close working relationship with local disaster management authorities is essential. The construction site management shall coordinate emergency procedures with agencies such as local fire, police, and medical services. In the event of large-scale disasters, coordination with regional and national disaster response teams may be necessary. All evacuation routes, shelter areas, and emergency procedures should be shared with these agencies.

SECTION 3 CONSTRUCTION PRACTICES

8 CONSTRUCTION CONTROL AND PRACTICES

8.1 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 Part 2 'Administration' of the Code. All applications for permits and issuance of certificates, etc shall be as given in Part 2 'Administration' of the Code. Employment of trained workers shall be encouraged for building construction activity.

8.1.1 *Proficiency Requirements for Construction Engineers including Structural Engineers*

8.1.1.1 *General*

In the construction industry, ensuring the proficiency of structural engineers and other personnel is essential for the safety, quality, and integrity of built structures. Standardizing proficiency requirements ensures that all professionals involved in construction projects possess the necessary skills, knowledge, and experience to fulfill their responsibilities effectively. These provisions set out the standardized proficiency requirements for construction engineers to promote safety, quality assurance and risk management.

8.1.1.2 *Safety*

Proficiency requirements for construction engineers should prioritize safety in all construction phases. Structural engineers, responsible for designing, analysing, and overseeing projects, shall demonstrate proficiency in safety-related standards and practices. The proficiency of engineers directly impacts the structural integrity of buildings and other constructions, ensuring that they meet the highest safety requirements.

8.1.1.3 *Quality assurance*

Standardized proficiency requirements help in ensuring consistency in the quality of construction projects. By setting clear standards, these requirements promote uniform levels of expertise among engineers and construction personnel, contributing to high-quality, durable structures that perform their intended functions over time.

8.1.1.4 *Risk management*

Construction projects involve inherent risks, including structural failures, cost overruns, and delays. Proficient engineers can identify potential risks early in the design and construction phases and implement appropriate mitigation measures. Standardized proficiency requirements shall ensure that all personnel involved are equipped with the necessary skills to manage and mitigate risks effectively.

8.1.1.5 *Professional development*

Construction engineers shall engage in continuous learning and professional development to remain current with industry advancements and evolving technologies. Standardized proficiency requirements shall promote a culture of lifelong learning, encouraging professionals to pursue certifications, specialized training programs, and new skills. This enhances the overall competence of the industry and maintains its competitiveness.

8.1.1.6 *Implementation of standardized proficiency requirements*

Implementing standardized proficiency requirements involves collaboration among industry stakeholders, including professional associations, educational institutions, regulatory bodies, and construction firms. The following key steps should be implemented to ensure compliance:

a) Defining core proficiency levels for different roles within the construction industry.
b) Developing standardized assessment tools, such as examinations or portfolio reviews, to evaluate proficiency.
c) Providing resources and support for ongoing professional development and skills enhancement.
d) Regularly reviewing and updating proficiency standards to reflect evolving industry trends, technologies, and best practices.

By standardizing proficiency requirements, the construction industry can enhance safety, quality, and professionalism while fostering innovation and sustainability in building practices. This concerted effort benefits not only engineers and construction personnel but also the communities they serve, ensuring that infrastructure projects meet the highest standards of excellence and integrity.

The following illustrates the key areas of proficiency required for construction engineers:

1) Health, safety, and environmental (HSE) awareness.
2) Planning, scheduling, and monitoring of construction activities.
3) Incoming material inspection to ensure compliance with project specifications.
4) Certification of measurements and processing of bills.
5) Management of labour resources.
6) Legal compliance with construction laws and regulations.
7) Risk management and mitigation strategies.
8) Knowledge management to ensure effective communication and documentation.
9) Contract closing.
10) Knowledge of design principles and standards.
11) Computer literacy for construction management software and design tools.

The sample format for proficiency status of construction employees at site as per the above proficiency is provided in Table 3.

Table 3 Proficiency Status of Construction Employees
(*Clause* 8.1.1.6)

Sl No.	**Name of Employee**	**Proficiency needed for Construction Personnel as per proficiency requirement mentioned above**										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**j**	**k**	**m**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
i)	Project Head	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
ii)	Structural	Y	N	NR	NR	NR	Y	Y	N	NR	Y	Y
iii)	Civil	Y	Y	Y	Y	Y	N	Y	N	Y	N	Y
iv)	Safety	Y	Y	N	NR	Y	Y	Y	Y	N	NR	Y
v)	Mechanical, Electrical and Plumbing	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y

vi)	Store	Y	N	Y	Y	N	Y	Y	N	N	NR	Y

NOTE:
Y = Proficiency to perform given activity is there
N = Proficiency is not there but can be provided when required
NR = Proficiency not required

8.1.2 *Verification of Reinforcement Detailing and Joint Approval of Concrete Pour Card by Structural Engineer and Project Manager*

8.1.2.1 Critical connections, such as beam to column junctions, beam to beam junctions, and footing to column junctions, should be demonstrated as mock-ups and should be approved by the structural engineer before the commencement of work. The approved mock-up details shall be strictly implemented during execution to ensure compliance.

8.1.2.2 An interactive session should be arranged between the structural engineer and the execution team before starting the work. This session should address any queries from the execution team and shall emphasize the importance of accurate reinforcement detailing in ensuring structural integrity.

8.1.2.3 During the design phase, the designer shall identify and mark critical structural elements on the drawings with special remarks. For these critical elements, a two-stage inspection process shall be implemented, consisting of an initial inspection by the site engineer, followed by a final inspection by the project manager.

8.2 Site Preparation

8.2.1 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.

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

8.3 Habitat for Construction Workers at Site

The habitat and other welfare measures for construction workers shall meet the requirements specified in **16**.

8.4 Construction of All Elements

8.4.1 Construction of all elements of a building shall be in accordance with good practice [7(18)]. It shall also be ensured that the elements of structure satisfy the appropriate fire resistance requirements as specified in Part 4 'Fire and Life Safety' of the Code, and quality of building materials/components used shall be in accordance with Part 5 'Building Materials' of the Code.

8.4.2 Construction of all accessibility features/elements in a building and its built environment shall be as per the requirements given in **13** of Part 3 ‘Development Control Rules and General Building Requirements’ of the Code.

8.4.3 All mechanical, electrical and plumbing (MEP) and other services in a building shall be installed in accordance with approved designs as per Part 8 'Building Services' of the Code and Part 9 'Plumbing Services including Solid Waste Management' of the Code. Proper sequencing of installation of various services shall be done for ensuring smooth construction activities. (*See* also **8.4.4**)

8.4.4 *Construction and Installation of Non-Structural Elements, Finishes, Building Services, Glass Fixing, and Building Maintenance Unit (BMU) Restraints*

8.4.4.1 *General*

All non-structural elements, finishes, building services, glass installations, and building maintenance unit (BMU) restraints, shall be constructed and installed in accordance with safety, durability, and performance requirements to ensure long-term serviceability. The design, materials, and construction practices used for these elements shall be in line with the overall building structure while maintaining the safety and comfort of occupants.

8.4.4.2 *Non-structural elements*

Non-structural elements such as partitions, cladding, and facade panels shall be installed to ensure they are secure and resilient under various load conditions, including wind, seismic forces, and accidental impacts. These elements shall be properly anchored to the structural frame, using fasteners and methods that accommodate movement due to thermal expansion or seismic activity.

8.4.4.2.1 *Seismic considerations*

Non-structural elements shall be designed to prevent falling or detachment in the event of an earthquake. This includes proper bracing, anchoring, and gap allowances to accommodate movement.

8.4.4.3 *Finishes*

Interior and exterior finishes, including flooring, tiling, wall coverings, and paintwork, shall be applied using materials and techniques that ensure durability and resistance to environmental conditions such as moisture, heat, and UV radiation.

All finishes shall be applied on surfaces that have been properly prepared, ensuring they are clean, stable, and suitable for application, with appropriate curing time and conditions. Adhesives and sealants used in the finishing process should be chosen according to environmental factors and exposure risks, to guarantee long-lasting adhesion.

8.4.4.4 *Building services installation*

Building services, including electrical, plumbing, HVAC systems, and fire protection systems, shall be installed in a manner that allows ease of maintenance and minimizes interference with the building's structural components.

a) *Electrical installations* – Electrical conduits, wiring, and fittings shall be installed with provisions for fire protection, easy access for repairs, and minimal impact on the building's structural integrity.

b) *Plumbing and drainage* – All pipes and fixtures shall be securely fastened and designed to accommodate building movements without leakages or damages.

c) *HVAC systems* – Ductwork and equipment should be installed with sufficient clearances, avoiding obstruction of structural elements or other building services. Systems shall be designed to handle building-induced vibrations and movement.

8.4.4.5 *Glass fixing*

The installation of glass panels and glazing shall ensure thermal insulation, structural stability, and occupant safety. Glass fixing should follow the specific wind, seismic, and impact loads expected for the building.

a) *Framing and support* – Glass shall be supported using robust framing systems, with proper sealants and gaskets to accommodate expansion and prevent air and water infiltration.

b) *Safety glass* – Laminated or toughened safety glass shall be used in high-risk areas like railings, large windows, and facades, ensuring protection against shattering and injury.

8.4.4.6 *BMU (Building Maintenance Unit) restraints*

BMU restraints shall be provided to ensure that suspended platforms and access equipment used for facade maintenance are securely anchored. This equipment shall be installed according to manufacturer recommendations, taking into account building geometry, height, and wind loads.

a) *Anchor points* – The BMU restraint system shall include permanent anchor points installed on rooftops and facades. These anchors should be load-tested periodically to ensure they remain secure.

b) *Safety harnesses* – All maintenance personnel shall be required to use appropriate fall protection systems, including harnesses and lifelines attached to certified anchor points.

8.4.4.7 *Integration with structural systems*

All non-structural elements and building services shall be installed in such a way that they do not compromise the structural integrity of the building. Installations should avoid cutting or drilling into key load-bearing components unless approved in the design phase.

8.4.5 Necessary temporary works required to enable permanent works, shall be executed in accordance with **9.**

8.4.6 *Thermal Insulation Practices for Glass and Glazing*

8.4.6.1 *General requirements for insulation in glazing systems*

Thermal insulation in glass and glazing systems shall be achieved through measures that minimize heat transfer between interior and exterior environments, ensuring optimal energy efficiency in buildings. The design and installation of glazing systems shall

incorporate effective insulation strategies that reduce heat loss in cold climates and minimize heat gain in warmer regions. The goal is to enhance energy efficiency, optimize indoor thermal comfort, and reduce heat loss or gain through glazed surfaces.

8.4.6.2 *Glass insulation*

8.4.6.2.1 *Insulated glazing units (IGU)*

Insulated glazing units improve energy efficiency by reducing heat transfer through multiple glass panes by an insulating air or gas-filled space. Low-E coatings further enhance performance by reflecting heat while allowing light to pass through. Warm-edge spacers and air-tight seals minimize thermal bridging and air leakage, optimizing indoor temperature stability. By reducing heating and cooling demands, IGU's lower energy consumption, enhance indoor comfort, and help meet energy efficiency standards, contributing to overall buildings sustainability.

8.4.6.3 *Shading devices*

Shading devices enhance thermal insulation for glazed surfaces by reducing solar heat gain and minimizing temperature fluctuations inside buildings. External shading elements, such as louvers, overhangs, and awnings, block direct sunlight, preventing excessive heat from entering through windows during hot periods. Internal shading solutions, like blinds or curtains, provide additional insulation by trapping heat near the glass surface, lowering the need for artificial heating or cooling.

8.4.6.4 *Thermal breaks in frames*

Frames for glazing systems should include thermal breaks, which are essential to interrupt heat conduction through the frame materials. These breaks shall be constructed from low-conductivity materials to ensure that the overall thermal performance of the glazing system is not compromised.

8.4.6.5 *Installation of sealants*

All glazing systems shall be installed with high-performance sealants to ensure airtight construction and prevent unwanted infiltration of air and moisture, which can degrade the thermal performance. Sealants used in glazing shall be chosen based on their compatibility with thermal expansion properties of both the glass and frame materials.

8.4.6.6 *Consideration of thermal bridges*

Thermal bridging through structural elements or framing shall be minimized. Glazing systems shall be designed and installed in such a way that thermal bridges, which can significantly reduce the insulating value, are avoided. A thermal bridge occurs where insulation is interrupted, allowing heat to flow more easily through a specific area, such as at window frames, corners, or wall-floor junctions. Mitigating thermal bridges with materials like thermal breaks or insulated spacers helps minimize heat loss in winter and heat gain in summer.

8.4.6.7 *Glazing alignment and airtightness*

During installation, the alignment of glazing panels shall be controlled to ensure tight tolerances and proper fitment. Misalignment that creates gaps or uneven pressure points can lead to thermal inefficiency and air leakage. Adequate measures, including weatherstripping, should be applied to maintain airtightness around the glazing assemblies.

8.4.6.8 *Performance monitoring and maintenance*

To maintain thermal insulation performance over time, routine inspection and maintenance of glazing systems shall be conducted. Deterioration of sealants, settling of frames, or damage to glazing layers shall be addressed promptly to prevent reduced insulation efficiency.

8.4.6.9 *Insulation in complex facades*

For buildings with complex glazed facades, where the ratio of glass to wall area is high, enhanced thermal insulation measures are essential. Strategies may include increasing the thickness of insulation in adjacent walls and optimizing the orientation of glass to limit thermal exposure to direct sunlight or cold winds.

8.4.6.10 *Climate-specific adaptation*

The thermal insulation practices applied to glazing systems shall be adapted to the climatic conditions of the project site. In cold climates, preventing heat loss shall be the primary concern, while in warmer climates, reducing heat gain shall take precedence.

8.5 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 Part 3 '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.

8.6 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; pre-engineered steel structures with reinforced concrete expanded polystyrene core based panel/other in-fill walls; pre-cast concrete system with columns, beams, walls, slabs, hollow core slabs and also 3D Volumetric components; precast large concrete panel (PLCP) System with structural members (wall, slab, etc) cast in a factory/casting yard and brought to the building site for erection and assembling; wall and slab with EPS cement sandwich panel to be used with RCC or steel structural frame; reinforced expanded polystyrene sheet core with sprayed concrete as wall and slab; aluminium form work system for monolithic concrete construction; expanded-steel panel reinforced with all-galvanised steel wire-struts serving both as the load-bearing steel structure and as the stay-in-place steel formwork filled with EPS alleviated concrete; stay in place light weight polymer formwork with cast in situ reinforced concrete and in-situ flooring slab; 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. Some of such construction technologies that have already proven their technical merits through third-party certification and successfully practiced are listed below.

8.6.1 *Flyash Expanded Polystyrene (Beads) Cement Sandwich Panels*

Flyash expanded polystyrene cement sandwich panels are lightweight solid core sandwich panels made of 5 mm non-asbestos fibre cement boards on both sides of panels as facing sheet and the core material of expanded polystyrene beads, admixture, cement, sand, fly ash and other bonding materials in mortar form. The core material in slurry state is pushed under pressure into preset moulds. Once set, it is moved for curing and ready for use with RCC or steel framed structure. These panels may be installed without any structural support up to 5 m only. Due to the sheets, the panels do not require plastering and water curing. These panels are joined with tongue and groove jointing system.

These panels may be used as non-load bearing walls/roof/floor panels for structures temporary or permanent, residential and commercial buildings, offices, hospitals, school, malls and shelters, etc.

These are non-load bearing panels and should be used as walling, floor and roofing with additional structural support, steel or RCC depending on the design. However, these may be used as single floor construction or stairs case slabs, kitchen/bathroom slabs etc. without support structure.

8.6.2 *3D Printing in Construction*

3D printing, also known as additive manufacturing, is a technology that constructs three-dimensional objects from digital models by adding material layer by layer. This process begins with a digital design, which is sliced into thin layers to guide the printer. In construction, 3D printing uses materials like concrete, polymers, and recycled materials to fabricate walls, panels, and even entire buildings. Key advantages include reduced material waste, faster construction times, and the ability to customize designs to specific site requirements. *See* Part 6 'Structural Design, Section 7 Prefabricated Concrete Construction' of the Code, for detailed guidelines.

8.6.3 *Precast Composites*

Precast composites may be employed in construction to enhance efficiency, structural integrity, and sustainability. These construction materials are fabricated off-site in a controlled environment and then transported to the construction site for assembly. These elements combine different materials, such as concrete, steel, and fibre-reinforced polymers, to enhance performance characteristics. Precast composites are particularly suitable for large-scale projects due to their ability to reduce construction time without compromising on structural performance or durability. Their use in both load-bearing and non-load-bearing applications shall be carefully evaluated by project engineers and authorities to ensure compliance with the design specifications.

Precast composite elements, including walls, floors, roofs, and structural components, shall meet the required strength, durability, and fire-resistance criteria. Their implementation should prioritize minimizing on-site construction time, ensuring high-quality control, and reducing material wastage. Furthermore, the use of precast composites is encouraged as a sustainable building practice, as they often involve less resource consumption and generate less construction waste. The integration of these materials in building designs should consider factors such as thermal and acoustic performance, energy efficiency, and cost-effectiveness, while maintaining flexibility in architectural and structural configurations.

8.7 Urban Roads/City Roads Planning and Construction

8.7.1 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 non-motorized). 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 land-use 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.
j) Pedestrian friendly access across the roads to the foot-over bridges, subways and public toilets.
k) Access to gates of residential/commercial properties integrated with the road through the footpath in front.
m) Sharing of NMV with footpath necessary at many locations.
n) Adequate provision of public conveniences and dust bins.
o) 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.
p) Low height plantation on central verges, avoiding plantation of trees.
q) Removal of crooked trees on footpaths for proper and safe utilization of footpath.
r) Removal of trees obstructing the carriage ways and their replantation, wherever feasible.
s) Freeing of trees embedded in the compound wall/dwarf walls on footpaths to save both the trees and the walls.
t) 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.
u) Proper location of signage boards so as to be safe from moving traffic near the footpath edges and give clear visibility.
v) Selection, procurement and installation of street furniture.
w) Selection, procurement and installation in respect of accessibility features as per the requirements given in **13** of Part 3 'Development Control Rules and General Building Requirements' of the Code.

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

8.7.2 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'.

8.8 Measures against pollution and hazard due to dust, smoke and debris, such as screens and barricading shall be installed at the site during construction. Barricades shall be of sufficient height, stability, and strength to prevent unauthorized access, ensure public safety, and protect adjacent structures. They shall also be equipped with warning signage indicating "WORK IN PROGRESS" or "RESTRICTED AREA". All barricades shall be regularly inspected and maintained to ensure their effectiveness throughout the

construction period. Plastic/tarpaulin sheet covers shall be used for trucks transporting fine materials liable to cause environmental pollution. In addition, barricades shall be designed to withstand wind loads, and provisions shall be made for adequate lighting around the perimeter to ensure visibility at night or in low-light conditions.

8.9 Construction in Hill Areas

8.9.1 *Site Selection and Development*

8.9.1.1 *Microzonation and site assessment*

Sites in hilly areas shall undergo microzonation to assess geological, seismological, hydrological, and environmental parameters. Site-specific studies are required to classify areas into different hazard zones, and development shall be regulated based on this classification. For details on microzonation and site assessment, reference shall be made to good practice [7(19)].

8.9.1.2 *Slope and Terrain Considerations*

Building sites shall be selected on stable slopes with minimal risk of landslides and soil erosion. Sites with steeper slopes require special design measures, including soil stabilization and terracing. For details on slope and terrain consideration, reference shall be made to good practice [7(20)].

8.9.2 *Retaining Structures*

8.9.2.1 *Types of Retaining Walls*

The type of retaining wall (for example, gravity, cantilever, gabion) shall be selected based on site conditions, soil characteristics, and design height. For details on types of retaining walls, reference shall be made to good practice [7(21)].

8.9.2.2 *Design Requirements*

Retaining walls shall be designed considering lateral earth pressure, surcharge loads, seismic forces, and hydrostatic pressures. Drainage provisions such as weep holes, drainage pipes, or filters are mandatory to prevent hydrostatic pressure build-up. For details on design requirements, reference shall be made to good practice [7(22)].

8.9.2.3 *Construction of Retaining Walls*

a) *Dry stone walls* – Dry stone retaining walls shall be constructed with locally available materials, ensuring proper interlocking and stability through structural design. For details on dry stone walls, reference shall be made to good practice [7(23)].

b) *Banded dry stone masonry walls* – These walls shall include reinforcement at regular intervals to enhance stability. For details on banded dry stone masonry walls, reference shall be made to good practice [7(24)].

c) *Cement stone masonry walls* – These walls shall be constructed with appropriate mortar mixes and maintained for structural integrity. For details on cement stone masonry walls, reference shall be made to good practice [7(25)].

d) *Gabion walls* – Gabion walls shall be constructed with corrosion-resistant materials and interlinked to provide resistance against various forces. For details on gabion walls, reference shall be made to good practice [7(26)].

8.9.2.4 *Reinforced cement concrete (RCC) cantilever retaining walls*

RCC cantilever retaining walls shall be designed for stability against sliding, overturning, and bearing capacity failure, following detailed reinforcement guidelines.

8.9.3 *Slope Stabilization Measures*

8.9.3.1 *Micropiles for slope stabilization*

Micropiles shall be used for slope stabilization in high-risk areas. The design shall consider load capacities with appropriate safety factors. For details on micropiles for slope stabilization, reference shall be made to good practice [7(27)].

8.9.3.2 *Vegetative slope stabilization*

Vegetative measures such as grass and shrub planting shall be integrated into slope stabilization strategies to minimize erosion, using locally adapted plant species.

8.9.4 *Building Design and Material Selection*

8.9.4.1 *Building orientation and layout*

Buildings shall be oriented to minimize earthwork, cut-and-fill activities, and adapt to the natural terrain. Foundation design shall follow stepped or terraced patterns as per slope requirements. For details on building orientation and layout, reference shall be made to good practice [7(28)].

8.9.4.2 *Material specifications*

Construction materials shall be chosen based on suitability to local climatic and geological conditions, with emphasis on lightweight materials for thermal efficiency and reduced structural loads. For quality requirements of building materials, reference shall be made to Part 5 ‘Building Materials’ of the Code.

8.9.5 *Drainage and Water Management*

8.9.5.1 *Surface drainage systems*

Surface drainage systems shall be designed to manage runoff effectively, using lined channels and cross-drainage structures to prevent erosion and water accumulation near foundations.

8.9.5.2 *Rainwater harvesting*

Buildings shall incorporate rainwater harvesting systems for water conservation and management, with systems designed to prevent contamination and overflow. For details on rainwater harvesting, reference shall be made to good practice [7(29)].

8.9.6 *Structural Design*

For structural design of the building, reference shall be made to Part 6 'Structural design' of the Code.

8.9.7 *Safety and Environmental Considerations*

8.9.7.1 *Worker safety*

Safety measures such as guardrails, netting, and protective equipment shall be provided for construction workers, and all activities shall follow prescribed safety standards for excavation and scaffolding. For details on safety for excavation work, reference shall be made to good practice [7(30)]. For details on scaffolding safety, reference shall be made to good practice [7(31)].

8.9.7.2 *Environmental protection*

Construction activities should minimize environmental impact, with requirements for reforestation, erosion control, and ecological preservation throughout the project lifecycle.

8.10 Construction in Marine Areas

8.10.1 *Site Selection and Development*

8.10.1.1 *Coastal zone classification and site assessment*

Sites in marine areas shall be classified based on coastal zone management plans, which assess parameters such as tidal range, wave action, storm surge, and potential for flooding and erosion. Site-specific studies shall be required to evaluate geological, hydrological, and environmental risks. Development in these areas shall be regulated according to hazard zones and coastal regulations.

8.10.1.2 *Shoreline and terrain considerations*

Building sites shall be selected on stable shorelines, avoiding areas prone to erosion, storm surge, and tidal inundation. Sites near the shoreline shall be protected by natural or artificial barriers such as dunes, mangroves, or breakwaters to reduce the impact of wave action and erosion.

8.10.2 *Foundation Design*

8.10.2.1 *Pile foundations*

In marine areas with soft or unstable soils, pile foundations shall be used to ensure stability. Piles shall be designed to withstand lateral forces from wave action, tidal flows, and scouring. For details on pile foundation design, reference shall be made to good practice [7(32)].

8.10.2.2 *Raft foundations*

Raft foundations may be used where soil conditions permit, designed to distribute loads evenly across soft, waterlogged soils. Special attention shall be given to settlement, buoyancy, and water table fluctuations. For details on raft foundations, reference shall be made to good practice [7(33)].

8.10.3 *Structural Design Considerations*

All structural components in marine environments, particularly those exposed to saltwater, shall be designed with corrosion-resistant materials or coatings to protect against the aggressive marine environment. Special attention shall be given to reinforced concrete, steel, and other metallic elements, which are prone to deterioration from salt spray and humidity. For structural design of the building, reference shall be made to Part 6 'Structural design' of the Code.

8.10.4 *Coastal Protection Measures*

8.10.4.1 *Seawalls and breakwaters*

Seawalls, revetments, and breakwaters shall be installed where necessary to protect coastal structures from wave action and prevent shoreline erosion. These structures shall be designed to dissipate wave energy and reduce the impact of tides and storm surges.

8.10.4.2 *Natural barriers and ecosystem restoration*

Where feasible, natural barriers such as mangroves, wetlands, and dunes shall be restored or maintained as the first line of defence against coastal hazards. These natural systems offer protection from waves and erosion while preserving biodiversity.

8.10.5 *Drainage and Water Management*

8.11.5.1 *Stormwater management*

Stormwater systems in marine areas shall be designed to handle large volumes of runoff, incorporating measures to prevent coastal flooding. Drainage systems shall direct water away from foundations and critical structures.

8.10.5.2 *Rainwater harvesting and desalination*

Buildings shall include systems for rainwater harvesting or desalination to ensure a sustainable water supply, especially in areas with limited freshwater resources. These systems shall be designed to prevent contamination and overflows.

8.10.6 *Material Selection and Durability*

Construction materials shall be selected for their durability in marine environments. Lightweight materials shall be used where appropriate to reduce load on foundations. For details on material selection, reference shall be made to Part 5 'Building Materials' of the Code.

8.10.7 *Environmental and Safety Considerations*

8.10.7.1 *Worker safety in marine conditions*

Safety protocols for workers in marine areas shall account for high winds, tides, and wave action, with measures such as life vests, guardrails, and protective equipment. (*See* also **8.9.7.1**)

8.10.7.2 *Environmental protection in marine areas*

Construction in marine areas should minimize impact on coastal ecosystems. Measures shall be taken to prevent pollution, manage waste, and protect marine habitats. Efforts should be made to preserve or restore natural coastal buffers, such as mangroves and wetlands.

8.11 Construction in Snowbound Areas

8.11.1 *Site Selection and Development*

8.11.1.1 *Site assessment and snow load consideration*

Sites in snowbound areas shall be assessed for snow accumulation patterns, wind direction, and the potential for snowdrifts and avalanches. The site-specific study shall include geological and hydrological assessments to identify the risks associated with snowmelt, frost heave, and freezing temperatures. Development in these areas shall be regulated based on the severity of winter conditions and hazard zones for snow loads and avalanches.

8.11.1.2 *Terrain and slope stability*

Building sites shall be selected on stable terrain with adequate drainage to prevent snowmelt from affecting foundations and access routes. Sites on steep slopes or in avalanche-prone areas shall include necessary protection measures, such as snow fences or barriers, to mitigate risk.

8.11.2 *Foundation Design*

8.11.2.1 *Frost-protected foundations*

Foundations in snowbound areas shall be designed to resist frost heave, which occurs due to freezing soil. Frost-protected shallow foundations or deep foundations, such as piles, may be used depending on the frost depth. Insulation and drainage measures shall be incorporated to prevent freezing under the foundation.

8.11.2.2 *Elevated foundations and snowmelt management*

Where heavy snow accumulation is anticipated, buildings shall include elevated foundations or raised platforms to prevent snow buildup from obstructing access or affecting the structure. Proper grading and drainage shall be provided to manage snowmelt and prevent waterlogging or damage to the foundation.

8.11.3 *Structural Design Considerations*

For structural design of the building, reference shall be made to Part 6 'Structural design' of the Code.

8.11.4 *Snow Management and Safety Measures*

8.11.4.1 *Snow removal systems and roof safety*

Buildings in snowbound areas should be equipped with snow removal systems, such as heated gutters, snow guards, or roof de-icing systems, to prevent snow and ice from sliding off the roof and causing damage or injury. Adequate provisions should be made for the safe removal and storage of snow around the building without obstructing access routes.

8.11.4.2 *Avalanche protection and snow barriers*

In areas prone to avalanches, structures shall include avalanche protection systems such as snow fences, deflection walls, or snow nets to shield the building and surrounding areas. Site plans must also ensure that snow shedding from roofs does not endanger pedestrians or vehicles.

8.11.5 *Drainage and Water Management*

8.11.5.1 *Snowmelt and drainage systems*

Drainage systems in snowbound areas shall be designed to handle large volumes of water from snowmelt, ensuring proper runoff management to prevent flooding and waterlogging. Heated drainage pipes or channels may be required to prevent freezing. The grading around buildings shall direct water away from the foundation and minimize the risk of ice formation on walkways and roads.

8.11.5.2 *Rainwater harvesting*

Where applicable, buildings shall incorporate rainwater or snowmelt harvesting systems to supplement water supply during winter months. Systems shall be designed to prevent contamination and ensure proper storage and management.

8.11.6 *Material Selection and Durability*

Construction materials shall be selected for their ability to withstand extreme cold, freeze-thaw cycles, and snow loads. Special consideration shall be given to durable materials for roof coverings, cladding, and windows to resist damage from ice, snow, and wind. For details on material selection, reference shall be made to Part 5 'Building Materials' of the Code.

8.11.7 *Environmental and Safety Considerations*

8.11.7.1 *Worker safety in snowbound conditions*

Safety protocols for workers in snowbound areas shall include measures to address cold stress, frostbite, and hypothermia. Protective clothing, heated work areas, and snow-clearing equipment shall be provided. Snow-covered areas around construction sites shall be regularly cleared, and access routes maintained to prevent accidents. (See also **8.9.7.1**)

8.11.7.2 *Environmental protection in snowbound areas*

Construction activities in snowbound areas should minimize disruption to local ecosystems, including forests, rivers, and wildlife habitats. Special attention should be given to erosion control and water management during snowmelt. Efforts should be made to maintain or restore vegetation to prevent soil degradation and enhance natural snow retention.

8.12 Transportation and erection of precast and prefabricated elements during construction on the site

After the segments are prepared for erection, a final inspection shall be conducted prior to dispatch, and the results shall be recorded in accordance with the dispatch checklist. The checklist shall include, but not be limited to, the following points:

a) In accordance with the erection sequence, the precast segment shall be loaded onto the trailer.
b) The capacity of the trailer shall be more than the maximum weight of the segment.
c) After loading on the trailer, the segment shall be tied with 4 number ratchet belt/chain with buckle (Capacity minimum 05 MT each).
d) Proper suitable packing shall be provided in between ratchet belt and segments to avoid any damage to rachet belts during transportation. This shall be checked by safety officer, project engineer and launching engineer before dispatch.
e) After each transportation, the rachet belt shall be checked by safety officer and launching engineer for any physical damage. If any damage is found, the belts shall be replaced immediately.
f) A marshalling vehicle, equipped with necessary gears, shall accompany the transporting vehicle.
g) A route survey shall be conducted prior to transportation.
h) Warning signage and a red banner flag shall be affixed to the rear of the trailer.

For erection of precast and prefabricated elements during construction on the site, reference shall be made to Part 6 ‘Structural Design, Section 7 Prefabricated Concrete Construction’ of the Code.

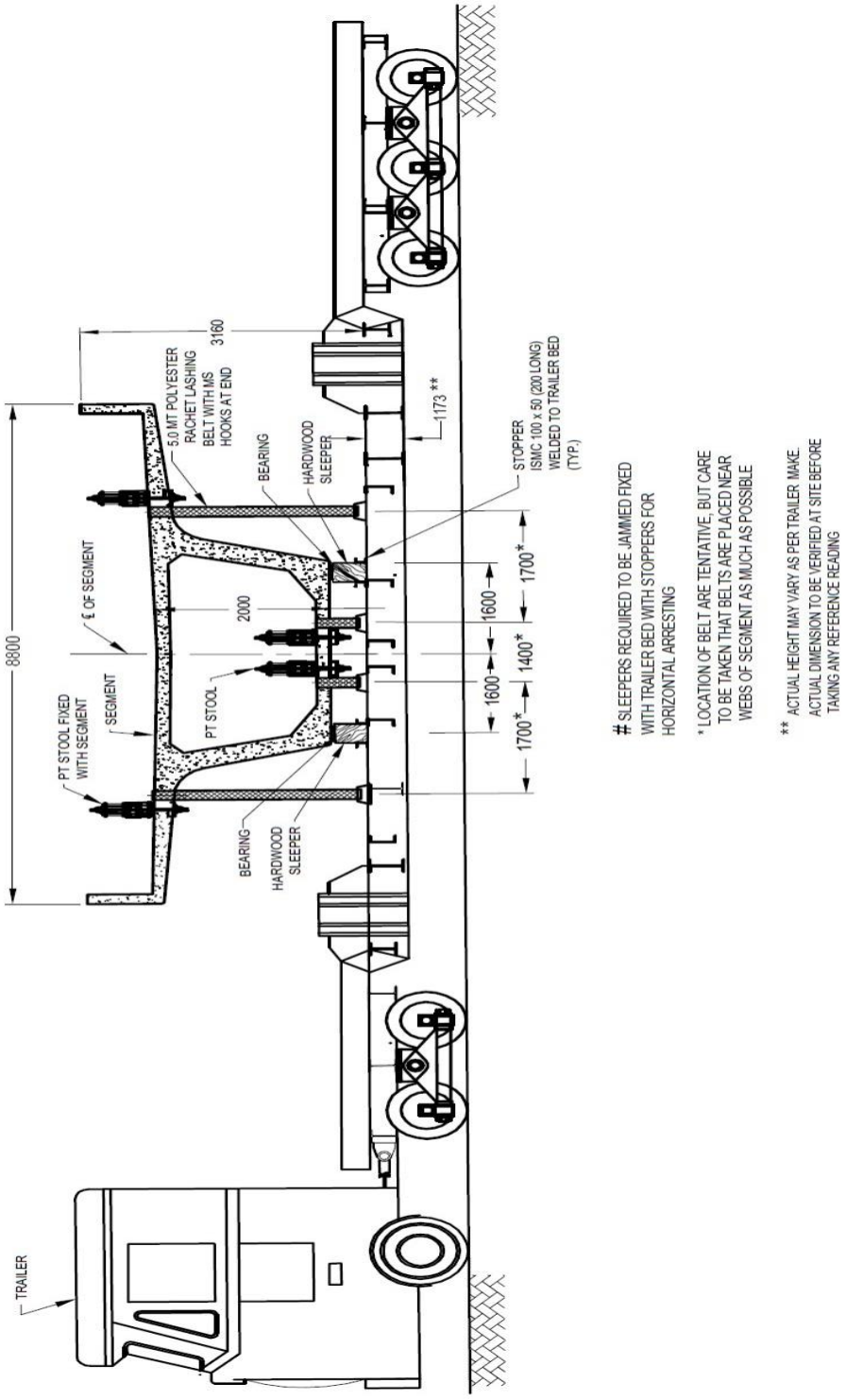


FIG. 3 TRANSPORT ARRANGEMENT FOR PRECAST ELEMENT

8.13 False Ceiling Design and Installation – *See* good practice [7(81)].

9 TEMPORARY WORKS

9.1 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 co-ordinator (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 as screw 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 **9.2** to **9.6** 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,

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

9.2 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 good practice [7(34)].

9.3 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 good practice [7(35)] 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 good practice [7(36)].

9.4 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 good practice [7(37)].

9.5 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. The design, installation, and dismantling of formwork shall account for risks associated with structural collapse.

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. Striking of formwork shall be governed by Part 6 'Structural Design, Section 5 Concrete' of the Code.

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

9.6 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 good practice [7(38)].

10 STORAGE, STACKING AND HANDLING PRACTICES

10.1 General

10.1.1 *Planning and Storage Layout*

10.1.1.1 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 manoeuverability 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.

10.1.1.2 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.

10.1.1.3 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.

8.1.1.4 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.

10.1.1.5 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.

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

10.1.2 *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.

10.1.3 *Protection Against Fire and Other Hazards*

10.1.3.1 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 4.5 m in height. The provisions given in good practice [7(39)] shall be followed. Explosives like detonators shall be stored in accordance with the existing regulations of *The Explosives Act*, 1884.

10.1.3.2 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.

10.1.3.3 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.

10.1.4 *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. Appropriate manual lifting and carrying aids, such as pallet trucks, sack barrows, trolleys, and lifting devices, shall be used to ensure safe and suitable handling for each task. The maximum weight a workman is permitted to lift by hand, carry overhead, or bear on the back or shoulders shall conform to the limits established by the *Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act*, 1996, and rules framed thereunder. 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.

10.2 Storage, Stacking and Handling of Materials

10.2.1 The storage, stacking and handling of materials generally used in construction shall be as given in **10.2.2** to **10.2.31**, which have been summarized in the form of a check list in Annex A. Exposure to asbestos fibres/dust is known to be harmful to health of

human beings. Prescribed guidelines in accordance with good practice [7(40)] shall be followed for handling and usage of asbestos cement products.

10.2.2 *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. 4). 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 minimise 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.

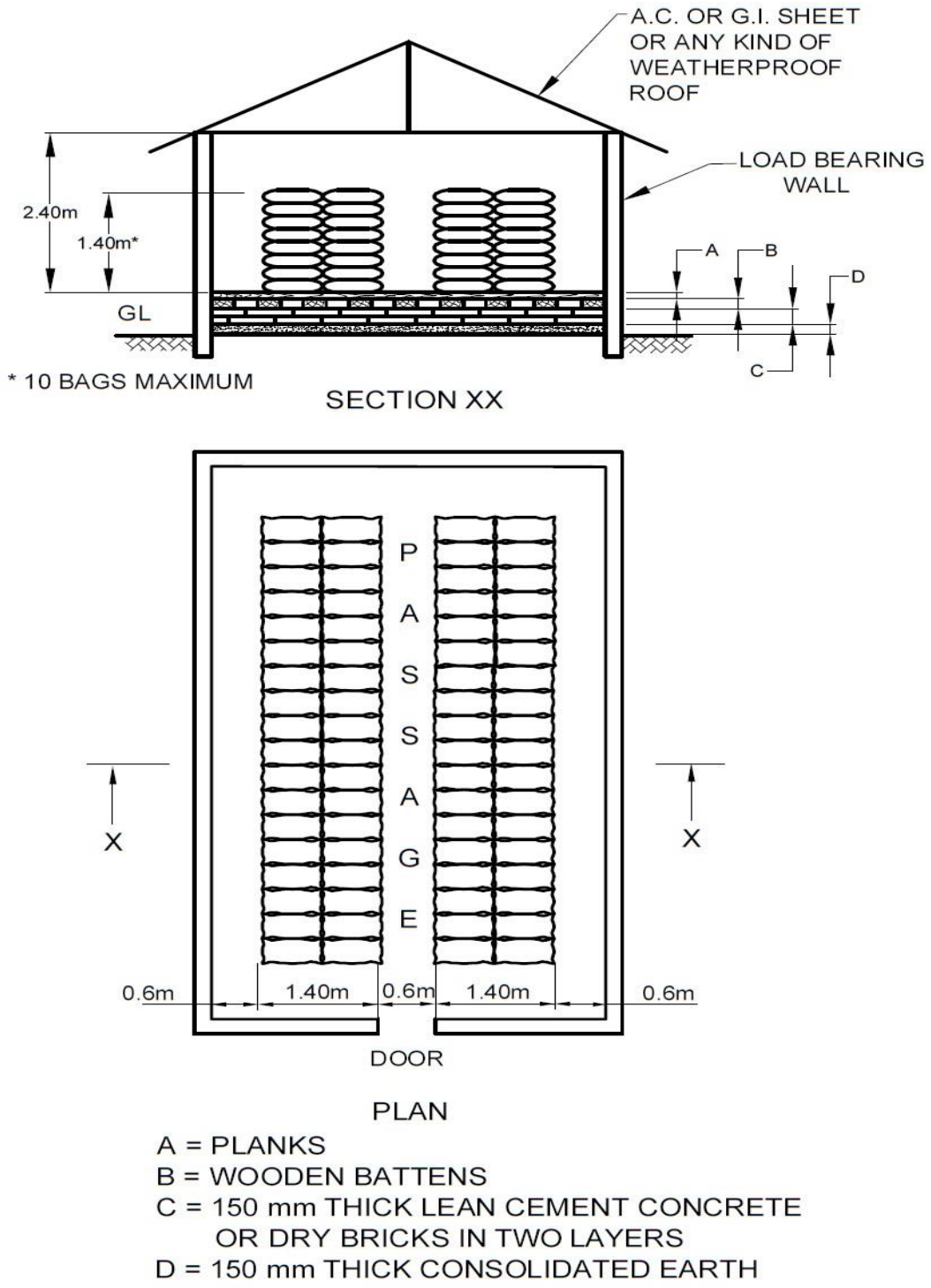


FIG. 4 TYPICAL ARRANGEMENT IN CEMENT GODOWN

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* **10.2.4***).*

10.2.3 *Lime*

10.2.3.1 *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* **10.2.4**.

10.2.3.2 *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 minimise 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 **10.2.2** 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* **10.2.4**.

10.2.3.3 *Dry slaked lime*

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

b) *Handling – See* **10.2.4**.

10.2.4 *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.

10.2.5 *Masonry Units*

a) *Stones* – Stones of different sizes, types and classification 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 minimise 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) to prevent 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 minimise 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 than 3.0 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 14 days 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.

10.2.6 *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 one 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.

10.2.7 *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.

10.2.8 *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* **10.2.4**.

10.2.9 *Cinder*

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

10.2.10 *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.

10.2.11 *Bamboo*

10.2.11.1 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.

10.2.11.2 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.

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

10.2.11.4 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:

a) Sodium pentachlorophenate : 1 percent solution
b) Boric acid + borax (1:1) : 2 percent solution
c) 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.

10.2.12 *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 **10.2.5** (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 minimised.

10.2.13 *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. Plastic end caps should be used on exposed steel bar ends to reduce the risk of injury to workers and other personnel.

Bars of different classification, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths as to minimise 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.

10.2.14 *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.

10.2.15 *Doors, Windows and Ventilators*

a) *Storage and stacking* – Metal and plastic doors, windows and ventilators shall be stacked upright (on their sills) on level ground preferably 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 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.

10.2.16 *Roofing Materials*

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

10.2.16.2 *Asbestos cement sheet*

a) *Storage and stacking* – Asbestos cement sheets shall be stacked horizontally to a height of not more than 1 m 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. Damaged sheets shall not be stacked with sound materials. All damaged sheets shall be salvaged as early as possible.

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. When using asbestos cement sheets, appropriate measures shall be implemented to control risks associated with respiratory hazards.

10.2.16.3 *Corrugated galvanized iron sheets and aluminium sheets*

a) *Storage and stacking* – Corrugated galvanized iron 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.

10.2.16.4 *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.

10.2.17 *Boards*

10.2.17.1 *Gypsum boards*

a) *Storage and stacking* – Gypsum boards shall be stored flat in a covered clean and dry place.
b) *Handling* – *See* **10.2.17.2** (b).

10.2.17.2 *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 x 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.

10.2.18 *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.

b) *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.

10.2.19 *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.

10.2.20 *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.

10.2.21 *Polyethylene Pipes*

a) *Storage and stacking* – Black polyethylene pipes may be stored either under cover or in the 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 horizontal racks 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.

10.2.22 *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.

10.2.23 *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 insure against displacement.

10.2.24 *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 **10.2.18** (a) shall be followed.

10.2.25 *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 standards [7(41)] {*see also* good practice [7(42)]}.

Each workman handling lead based paints shall be issued ½ litre milk per day for his personal consumption.

10.2.26 *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.

b) *Handling* – *See* **11.14.3.1.2** and **11.14.3.4**.

10.2.27 *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.

10.2.28 *Flammable Materials*

a) *Storage and stacking* – In addition to the requirements as laid down in **10.1.3**, 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 possible 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.

10.2.29 *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.

10.2.30 *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.

10.2.31 *Other Materials*

Polymeric materials such as coatings, sheeting, reflective surfacing/sheeting, etc, shall be stored as per the manufacturers' 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.

10.2.32 *Special Considerations*

10.2.32.1 Materials constantly in use shall be relatively nearer to the place of use.

10.2.32.2 Heavy units like precast concrete members shall be stacked near the hoist or the ramp.

10.2.32.3 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.

10.2.32.4 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 good practice [7(42)]. It is desirable that a minimum of two extinguishers are provided at each such location.

10.2.32.5 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.

10.2.32.6 *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.

10.2.32.7 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.

10.3 Unloading Rail/Road Wagons and Motor Vehicles

10.3.1 *Loading and Unloading from Rail/Road Wagons*

10.3.1.1 Appropriate warning signals shall be displayed to indicate that the wagons shall not be coupled or moved.

10.3.1.2 The wheels of wagons shall always be sprigged or chained while the wagons are being unloaded. The brakes alone shall not be depended upon.

10.3.1.3 Special level bars shall preferably be used for moving rail wagons rather than ordinary crow bars.

10.3.1.4 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.

10.3.1.5 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.

10.3.2 *Loading and Unloading from Motor Vehicles*

10.3.2.1 The motor vehicles shall be properly blocked while being loaded or unloaded; brakes alone shall not be depended upon to hold them.

10.3.2.2 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.

10.3.2.3 Adequate lighting shall be provided while loading/unloading.

10.3.3 *Handling Heavy/Long Items*

10.3.3.1 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.

10.3.3.2 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.

10.3.3.3 Similar procedure as outlined under **10.3.3.2** shall be followed for manual unloading of long or heavy items.

SECTION 4 SAFETY IN CONSTRUCTION AND DEMOLITION

11 SAFETY IN CONSTRUCTION OF ELEMENTS OF A BUILDING

11.1 General

11.1.1 Safety in construction is required during all the operations carried out on-site, that is, drilling, blasting, excavation, piling, tunnelling, foundations, road making, erection of steel structures, framed concrete structures, handling of hazardous materials, transportation of materials and equipment, etc. Some common issues include electricity supply, poisoning due to toxic fumes and airborne contaminants, poor material management, mishandling of heavy-weight goods, improper openings, etc. The Engineer-in-charge of civil works and buildings, site engineers, and project managers should be well-versed with all the safety protocols. The hazards can be controlled by the following measures:

a) formulation and implementation of work specific safety protocols,
b) provision of compliant personal protective equipment (PPE) and safety equipment (first-aid, fire-fighting, etc.),
c) proper material management SOP (Standard Operating Procedure),
d) adopting lean construction practices,
e) avoiding over speeding in construction or adherence to agile construction management,
f) manpower must be skilled, qualified and trained to operate heavy machinery,
g) electrical connections and wires shall be double insulated and connected to a 30 mA residual current circuit breaker (RCCB) or earth leakage circuit breaker (ELCB),
h) installing early warning sensors at critical sites,
j) provision of proper lighting and ventilation, and

k) provision shall be made for hard barricading at slab leading edges, stairways, balconies, lift shaft openings, and excavated area edges to prevent accidental falls of persons.

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 conform to **8.4**. *See* **12** of Part 8 'Building Services, Section 2 Electrical and Allied Installations' of the Code for requirements on electrical safety aspects specific to construction and demolition sites.

11.1.2 *Other Laws*

Nothing herein stated shall be construed to nullify any rules, regulations, safety standards or statutes of the local state governments or those contained in the various Acts of the Government of India. 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.

11.1.3 *Safety Management*

11.1.3.1 The safety of personnel engaged in building construction should be ensured through a well planned and well organized mechanism by employing the guidelines given in good practice [7(13)].

11.1.3.2 Notwithstanding the guidelines given in **11.1.3.1**, all provisions given in relevant Act/Rules/Regulations as amended from time to time shall be followed; in this regard, reference shall also be made to the *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act***,** 1996 and the rules/regulations framed thereunder as well as to the *Central Electricity Authority (Measures relating to Safety and Electric Supply) Regulations*, 2023.

11.2 Temporary Construction, Use of Side Walls and Temporary Encroachments

11.2.1 *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.

11.2.1.1 Temporary structure referred to in **11.2.1** 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, foot-bridges, etc.

11.2.2 For detailed information regarding fire safety aspects in respect of construction, location, maintenance and use of temporary structures [mentioned in **11.2.1.1**(a)] including pandals used by public for outdoor assembly, reference may be made to good practice [7(43)].

11.2.3 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.

11.2.4 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.

11.3 Testing

11.3.1 *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 Part 6 ‘Structural Design’ of the Code {*see also* good practices [7(44)]}.

11.3.1.1 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.

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

11.4 Inspection and Rectification of Hazardous Defects

11.4.1 *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 owner and direct him to take immediate remedial measures to remove the hazard/violation.

11.4.2 *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 (*see also* Part 2 ‘Administration’ of the Code).

11.4.3 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.

11.5 Foundations

11.5.1 *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 workers 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.

11.5.2 *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. The person causing excavation shall be absolved of responsibility for any loss of property or life in the adjoining property. To prevent structural damage to adjoining buildings, the excavation process shall include pre-construction surveys to document the condition of neighbouring structures, including cracks, deformations, and existing weaknesses. This record will serve as a reference in case any structural damage is claimed during or after excavation.

11.5.2.1 *Protection to neighbouring 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.

Wherever 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. Additional precautionary measures, such as limiting pile-driving intensity and employing vibration-dampening techniques, shall be adopted where the risk of structural damage to adjacent buildings is high. Pile driving and excavation activities shall be closely monitored.

In case of bored piles, 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 minimised by approved technique and the operation should be

planned. Real-time geotechnical monitoring systems, including inclinometers and piezometers, shall be considered to monitor soil movement and groundwater levels during excavation. This helps detect any early signs of soil displacement that could affect adjacent structures. Regular data collection from these systems shall be reviewed to assess the need for corrective measures.

Additionally, during excavation, continuous monitoring of adjacent structures using crack gauges, settlement markers, or tilt meters shall be carried out to detect early signs of displacement or damage. Provisions should also be made for real-time data collection to allow for immediate corrective actions if any adverse movements are detected. In high-density urban environments or where there are particularly sensitive buildings, automated monitoring systems with alarm thresholds may be installed to trigger immediate notifications if critical displacement or movement occurs. These systems shall be calibrated according to the soil and structural conditions present at the site.

11.5.3 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 (*see* Part 2 'Administration' of the Code).

11.5.4 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 workers 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. The soil investigation report shall be used as the basis for determining the most appropriate shoring method.

The type of shoring system shall be selected based on the excavation depth and soil characteristics. For cohesive soils, temporary slope support may be sufficient, while granular or loose soils may require more robust shoring systems such as steel sheet piles. In deep excavations, multiple levels of bracing or tiebacks shall be used to prevent wall collapse and ensure structural stability. The shoring system shall be installed progressively as excavation advances to ensure that all exposed soil faces are supported at all times. Regular inspections of the shoring system shall be conducted during excavation to check for any signs of movement, deformation, or distress in the supports. Load monitoring devices such as strain gauges may be installed to monitor stress levels in the shoring members and detect any overloading conditions early. Temporary drainage systems shall be installed to prevent water accumulation at the excavation site, as excess water can compromise the stability of the shoring system and cause soil erosion or collapse. For detailed information regarding safety requirements during excavation reference may be made to good practice [7(38)].

11.6 General Requirements and Common Hazards During Excavation

11.6.1 *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.

11.6.2 *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.

11.6.2.1 *Other surcharges*

Proximity of buildings, piles of lumber, crushed rocks, sand and other construction 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.

11.6.3 *Type 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 workers 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.

11.6.4 *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.

11.6.5 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.

11.6.5.1 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.

11.6.6 *Health Hazards*

Where gases or fumes are likely to be present in trenches, sufficient mechanical ventilation, to protect the health and safety of persons working there, shall be provided. 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.

11.6.7 *Safety of Materials*

Materials required for excavation, like ropes, planks for gangways and walkways, ladders, etc, shall be inspected by the engineer-in-charge who shall ensure that no accident shall occur due to the failure of such materials (*see* Part 5 'Building Materials' of the Code).

11.6.8 *Fencing and Warning Signals*

Where excavation is going on, for the safety of public and the workers, 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.

11.6.9 *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.

11.6.10 *Vibrations from Nearby Sources*

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

11.6.11 *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 fire explosion under favourable circumstances. Care should, therefore, be taken to avoid all sources of ignition in such places.

11.6.12 *Location of Underground Services*

Before carrying out any excavation work, 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 workers engaged in excavation work and calamities for the general public.

11.7 Piling and Other Deep Foundations

11.7.1 *General*

11.7.1.1 *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.

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

11.7.1.3 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.

11.7.1.4 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.

11.7.1.5 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.

11.7.1.6 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.

11.7.1.7 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.

11.7.1.8 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.

11.7.1.9 Every crane driver or hoisting appliance operator shall be competent to the satisfaction of the engineer-in-charge 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 requirement as may be specified in *the Building and other Construction Workers' (Regulation of Employment and Conditions of Service Central) Rules, 1998*.

11.7.1.10 Working in compressed air, in case of deep foundations, requires several precautions to be observed to safeguard the workers against severe hazards to life, compressed air disease and related ailments. For detailed information regarding safety requirements, reference may be made to good practice [7(45)].

11.7.2 *Piling Rig*

11.7.2.1 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.

11.7.2.1.1 Pile drivers shall not be erected in dangerous proximity to electric conductors.

11.7.2.1.2 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.

11.7.2.2 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.

11.7.2.3 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.

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

11.7.2.4.1 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 maintained in good condition at all times.

11.7.2.5 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.

11.7.2.6 Pile driving equipment in use shall be inspected by a competent engineer at regular intervals not exceeding three months. Also, a register shall be maintained at the site of work for recording the results of such inspections. 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.

11.7.2.6.1 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.

11.7.2.7 All bolts and nuts which are likely to be loosened due to vibration during pile driving shall be checked regularly and tightened.

11.7.2.8 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.

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

11.7.2.10 For every hoisting machine and for every chain ring 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, their date of purchase, 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.

11.7.2.11 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, they shall be adequately counter-balanced and the tilting device shall be secured against slipping.

11.7.2.12 Adequate precautions shall be taken to prevent a pile driver from overturning, if a wheel breaks.

11.7.2.13 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.

11.7.2.14 Adequate precautions shall be taken to prevent the hammer from missing the pile.

11.7.2.15 If necessary to prevent danger, long piles and heavy sheet piling should be secured against falling.

11.7.2.16 Wherever steam boilers are used, the safety regulations of boiler shall be strictly followed and safety valves shall be adjusted to 0.07 N/mm^2 in excess of working pressure accurately.

11.7.2.17 Where electricity is used as power for piling rig, only armoured cable conforming to the relevant Indian Standard shall be used and the cable shall be thoroughly waterproofed.

11.7.3 *Operation of Equipment*

11.7.3.1 Workers employed in the vicinity of pile drivers shall wear helmets conforming to accepted standard [7(46)].

11.7.3.2 Piles shall be prepared at a distance at least equal to twice the length of the longest pile from the pile driver.

11.7.3.3 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.

11.7.3.4 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.

11.7.3.5 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.

11.7.3.6 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.

11.7.3.7 When piles are driven at an inclination to the vertical, if necessary to prevent danger, these should rest in a guide.

11.7.3.8 No steam or air line shall be blown down until all workers are at a safe distance.

11.7.4 *Sheet Piling*

11.7.4.1 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.

11.7.4.2 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.

11.7.4.3 Workers handling sheets should wear gloves.

11.7.4.4 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.

11.7.4.5 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.

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

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

11.8 Walls

11.8.1 *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.

11.8.2 *Scaffold*

Properly designed and constructed scaffolding built by competent workers 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 accepted standard [7(47)]. 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 workers 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 non-combustible 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 workers. 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 good practices [7(48)].

11.8.2.1 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.

11.8.2.2 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 workers when the workers are required to work on scaffoldings.

11.8.3 *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 set up 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 300 mm 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 workers under ladder. For detailed information regarding safety requirements for use of ladders, reference may be made to good practice [7(49)].

11.8.4 *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.

11.8.4.1 *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 reference may be made to good practice [7(50)]. Every wall opening from which there is a drop of more than 1 200 mm 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.

11.8.4.2 Every chute wall opening from which there is a drop of more than 1 200 mm shall be guarded by one or more of the barriers specified in **11.8.4.1** or as required by the conditions.

11.8.5 *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.

11.9 Common Hazards During Walling

11.9.1 *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.

11.9.2 *Haulage of Materials*

11.9.2.1 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.

11.9.2.2 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.

11.9.3 *Electrical Hazards*

No scaffolding, ladder, working platform, gangway runs, etc, shall exist within 3 m from any uninsulated electric wire.

11.9.4 *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.

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 3 kg capacity shall be kept handy.

11.9.5 *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.

11.9.6 *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.

11.10 Roofing

11.10.1 Prevention of accidental falling of workers 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. Prominent signage stating 'WARNING: PEOPLE WORKING OVERHEAD' shall be displayed at appropriate locations in areas below roof work to alert personnel and reduce the risk of injury from overhead activities. This signage should be positioned to ensure visibility from a minimum distance of 6 m.

11.10.2 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 (such as full body harness with rope grab fall arrester system with lifeline rope) to work on the roof.

11.10.3 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.

11.10.4 *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.

11.10.5 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.

11.10.6 *Guarding of Floor Openings and Floor Holes*

11.10.6.1 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,

a) a railing with toe board on all exposed sides; or
b) a floor hole cover of 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.

11.10.6.2 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 cannot walk directly into the opening.

11.10.6.3 *Guarding of open-side floors and platform*

Every open-sided floor or platform 1 200 mm or more above adjacent floor or ground level shall be guarded by a railing (or the equivalent) on 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,

a) persons may pass;
b) there is moving machinery; or
c) there is equipment with which falling materials could create a hazard.

For detailed information, reference may be made to good practice [7(50)].

11.11 Anchoring of Various Non-Structural Elements (NSE) and Building Services in Order to Secure them Properly with the Building

A non-structural component refers to any mechanical, electrical, and plumbing (MEP) services, equipment, systems, furniture, or architectural elements that are not part of the primary structure but play an important role in fulfilling the functional requirements of a building. These components are typically fixed to the building's floor, walls, roof, or slab using anchoring system. Proper selection and installation of anchoring systems are critical to ensuring safety and performance. The following points shall be considered during the selection and installation of anchors:

a) *Loading* – All relevant loads, including dead load, live load, seismic load, temperature load, vibration load, and any other applicable loads from non-structural elements, shall be taken into account.

b) *Design of anchors* – The anchor design shall comply with relevant provisions, considering the characteristics of the parent material or the main structural component where the anchors will be installed.
c) *Selection of anchors* – The selection process shall consider environmental conditions, fire safety requirements, and corrosion protection measures.
d) *Quality checks* – Regular quality checks shall be performed, and related records shall be maintained.
e) *Installation* – The installation process shall involve identifying the location of reinforcement, post-tensioning cables, and electrical conduits to avoid during anchor placement. The layout shall be meticulously planned, and detailed drawings shall be prepared. The manufacturer's specifications and installation manual shall be followed. The depth and diameter of the hole shall meet the design requirements, and the hole shall be thoroughly cleaned before installation. In the case of resin grouting, ensure that the holes are dry and clean to prevent air pockets. Proper quality checks and records shall be maintained throughout the process.

11.12 Additional Safety Requirements for Erection of Concrete Framed Structures (High-Rise Buildings)

11.12.1 *Handling of Plant*

11.12.1.1 *Mixers*

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.

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.

When workers are cleaning the inside of the drums, 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.

11.12.1.2 *Cranes*

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 **9.3** shall also be complied with.

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.

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 **10.2.23** (a).

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.

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

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.

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

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

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

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.

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

When the bucket 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.

A standard code of hand signals shall be adopted in controlling the movements of the crane, and both the driver and the signaller 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.

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

11.12.1.3 *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 workers and plant shall be routed to avoid crossing, as much as possible, the truck lanes. A speed limit of up to 15 kmph is recommended within the construction project site. Vehicles should be equipped with an audio-visual reverse alarm system to ensure adequate warning during reversing manoeuvres.

11.12.1.4 *Concrete pumps (Air compressor operated)*

Safety requirements in accordance with good practice [7(51)] shall be followed.

11.12.2 *Formwork*

11.12.2.1 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 {*see also* with good practice [7(44)]}.

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

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

11.12.2.4 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.

11.12.2.5 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.

11.12.2.6 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.

11.12.2.7 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.

11.12.2.8 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.

11.12.2.9 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.

11.12.2.10 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.

11.12.2.11 Sills under the supports shall be set on firm 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 strata.

11.12.2.12 All centering shall be finally, inspected to ensure that,

a) footings or sills under every post of the centering are sound.
b) all lower adjustment screws or wedges are sung against the legs of the panels.
c) all upper adjustment screws or heads of jacks are in full contact with the formwork.
d) panels are plumb in both directions.
e) all cross braces are in place and locking devices are in closed and secure position.
f) In case of *Chhajas* and balconies, the props shall be adequate to transfer the load to the supporting point.

11.12.2.13 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.

While pouring concrete, it should be placed in such a manner that the load should be transmitted to the support of formwork uniformly without causing high eccentric load.

Caution shall be exercised to avoid heap storage of bricks/sand in roof/floor slab as it may lead to failure of slab.

11.12.2.14 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 workers 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.

11.12.2.14.1 The particular order in which the supports are to be dismantled should be followed according to the instructions of the site engineer.

11.12.3 *Ramps and Gangways*

11.12.3.1 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 workers. 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.

11.12.3.1.1 Ramps and gangways meant for transporting materials shall have even surface and be of sufficient width and provided with skirt boards on open sides.

11.12.4 *Materials Hoists*

11.12.4.1 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.

11.12.4.2 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.

11.12.4.3 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.

11.12.4.4 Hoistways shall be protected by a substantial enclosure at ground level, at all access points and wherever persons may be struck by any moving part.

11.12.4.5 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.

11.12.4.6 All gates shall be fitted with electronic or mechanical interlocks to prevent movement of the hoist in the event of a gate being opened.

11.12.4.7 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).

11.12.4.8 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.

11.12.4.9 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 be employed.

11.12.4.10 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.

11.12.4.11 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.

11.12.4.12 The platform of a goods hoist shall carry a notice stating,

a) the safe working load; and
b) that passengers shall not ride on the hoist.

11.12.4.13 All hoist operators shall be adequately trained and competent, and shall be responsible for ensuring that the hoist is not overloaded or otherwise misused.

11.12.4.14 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.

11.12.4.15 Every hoist shall be inspected at least once each week by a competent person and a record of these inspections kept.

11.12.5 *Prestressed Concrete*

11.12.5.1 In pre-stressing operations, operating, maintenance and replacement instructions of the supplier of the equipment shall be strictly adhered to.

11.12.5.2 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.

11.12.5.3 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.

11.12.5.4 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.

11.12.5.5 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 workers from working behind the jacks when the stressing operation is in progress.

11.12.5.6 Necessary shields should be put up immediately behind the prestressing jacks during stressing operations.

11.12.5.7 Wedges and other temporary anchoring devices shall be inspected before use.

11.12.5.8 The prestressing jacks shall be periodically examined for wear and tear.

11.12.5.9 Prestressing shall be done in accordance with Part 6 ‘Structural Design, Section 5 Concrete’ of the Code.

11.12.6 *Erection of Prefabricated Members*

11.12.6.1 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°.

11.12.6.2 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.

11.12.6.3 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.

11.12.6.4 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.

11.12.6.5 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. Lifting, handling and installation of prefabricated members shall be in accordance with Part 6 'Structural Design, Section 7 Prefabrication Concrete Construction' of the Code.

11.12.6.6 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.

11.12.7 *Heated Concrete*

When heaters are being used to heat aggregates and other materials and to maintain proper curing temperatures, the heaters shall be frequently checked for functioning and precautions shall be taken to avoid hazards in using coal, liquid, gas or any other fuel.

11.12.8 *Structural Connections*

11.12.8.1 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.

11.12.8.2 The packing of joints shall be carried out in accordance with the assembly instructions.

11.12.8.3 Levelling 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.

11.12.8.4 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.

11.12.9 Workers working in any position where there is a falling hazard shall wear safety belts or other adequate protection shall be provided.

11.13 Additional Safety Requirements for Erection of Structural Steel Work

11.13.1 *Safety Organization*

The agency responsible for erecting the steel work should analyse 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.

11.13.2 *Safety of Workpersons*

11.13.2.1 *General*

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.

The helmets shall be worn properly and at all times during the work and shall conform to the accepted standard [7(46)].

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 accepted standard [7(52)] and should suit individual workers.

The welders and gas cutters shall be equipped with proper protective equipment like gloves, safety boots, aprons and hand shields {*see* accepted standard [7(53)}. The filter glass of the hand shield shall conform to the accepted standard [7(52)] and should be suitable to the eyes of the particular worker.

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.

Warning signs shall be displayed where necessary to indicate hazards, for example (a) '440 V', (b) 'DO NOT SMOKE', (c) 'MEN WORKING AHEAD', etc. Hand lamps shall be of low voltage preferably 24 V to prevent electrical hazards.

All electrically operated hand tools shall be provided with double earthing.

11.13.2.2 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.

11.13.2.3 When a number of trusses or deep girders are 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.

11.13.2.4 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.

11.13.2.5 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.

11.13.2.6 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.

11.13.2.7 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.

11.13.2.8 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.

11.13.2.9 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 not 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.

11.13.2.10 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 the procedure given in the accepted standard [7(54)]. 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 are tight enough.

11.13.2.11 When the men can work safely from the steel structure itself, this is preferable to hanging platforms or scaffolds, as it eliminates additional operations, which in turn, reduces the hazard of an accident. 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. 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 day.

11.13.2.12 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 from ground to provide safety to people. The safety net should be made from man-made or machine-made fibre ropes which are UV stabilized and conforming to the accepted standard [7(55)].

11.13.2.13 *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 good practice [7(56)].

The workers should be instructed not to throw objects like hot rivets, cigarette stubs, etc, around. Sufficient fire extinguishers shall be placed at strategic points. Extinguishers shall always be placed in cranes, hoists, compressors and similar places. Where electrical equipment are involved, CO_2 or dry powder extinguishers shall be provided {*see also* good practice [7(42)]}.

11.13.2.14 Riding on a load, tackle or runner shall be prohibited.

11.13.2.15 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 acceptable standards [7(57)] shall be used for guying.

11.13.2.16 *Lifting appliances*

Precautions as laid down in **11.12.1.2** shall be followed.

11.13.2.17 *Slinging*

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.

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 alongwith a loaded sling. When idle slings are carried they shall be hooked.

While using multilegged 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.

11.13.2.18 *Riveting operations*

11.13.2.18.1 *Handling 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.

11.13.2.18.2 *Riveting dollies*

Canvas, leather or rope slings shall be used for riveting dollies. Chain shall not be used for the purpose.

11.13.2.18.3 *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.

11.13.2.18.4 *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 ready for quenching the fire during riveting operations and to prevent fires when working near inflammable materials.

11.13.2.19 *Welding and gas cutting*

11.13.2.19.1 For safety and health requirements in electric gas welding and cutting operations, reference may be made to good practice [7(58)]. The recommendations given in **11.13.2.19.2** to **11.13.2.19.4** are also applicable.

11.13.2.19.2 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.

11.13.2.19.3 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.

11.13.2.19.4 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.

11.13.3 *Safety of Structure*

11.13.3.1 *General*

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.

11.13.3.1.1 Erection of columns shall be immediately followed by vertical bracing between columns before the roof structure is erected.

11.14 Miscellaneous Items

11.14.1 *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. Workers 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.

11.14.2 *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.

11.14.3 *Construction Involving the Use of Hot Bituminous Tar Materials*

11.14.3.1 *Safety programme*

11.14.3.1.1 *General*

On all major works, an experienced and competent ~~foreman or supervisor~~ safety officer shall be placed under project in-charge of the work, and shall be made responsible for the strict observance of the safety rules. He shall stock the necessary protective equipment, fire extinguishing equipment, first-aid kit, etc. He shall also ensure the availability of adequate supply of drinking water for the workers. He shall also keep a record of the accidents taking place on any particular job, with reasons thereof, and shall suggest suitable remedial measures to the management for prevention thereof.

11.14.3.1.2 *Protective covering*

Workers engaged on jobs involving handling of hot bitumen, tar, and bituminous mixtures shall use protective wears, such as boots and gloves, preferably of asbestos or otherwise of rubber; goggles and helmet. No workers shall be permitted to handle such materials without wearing the needed protective covering.

11.14.3.1.3 *Fire fighting arrangements*

When heating and handling of hot bituminous materials is to be done in the open, sufficient stocks of clean dry sand or loose earth shall be made available at the work site to cope with any resultant fires. When neither such materials are available, nor are any suitable type of fire extinguishers provided at the work site in the open, and reliance has to be on using water for fighting any fire, the water supply available should be in abundance and the water shall be applied to the fire in the form of spray. When heating of bituminous materials is carried out in enclosed spaces, sufficient number of properly maintained dry powder fire extinguisher or foam extinguisher conforming to accepted standards [7(41)] shall be kept in readiness on the work site.

11.14.3.1.4 *Warning signage*

The appropriate warning sign to be used such as “MEN AT WORK” sign during working, or the “NARROW ROAD AHEAD” sign if half of the road width is available for traffic,

should be displayed. During night, there should be adequate lighting with red reflectors/flashers/blinkers.

NOTE – For guidance on road signs, reference may be made to IRC 67:2022 'Code of Practice for Road Signs (fourth revision)'. 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 (first revision)'.

11.14.3.2 *Sprayer, spreader/paver*

11.14.3.2.1 *Sprayer*

The sprayer shall be provided with a fire resisting screen. The screen shall have an observation window. Piping for hot tar and bitumen shall be adequately insulated to protect workers from injury by burns. Flexible piping work under positive pressure shall be of metal which shall be adequately insulated. Workers shall not stand facing the wind directions while spraying hot binder, lest it may fall on them causing burns.

11.14.3.2.2 *Spreader/Paver*

Spreaders in operation shall be protected by signals, signs or other effective means. People should be warned against walking over hot mixture laid. Gravel spreaders shall always keep a safe distance from sprayer. Elevated platforms on spreaders shall be protected by suitable railing and be provided with an access ladder.

11.14.3.3 *Equipment for heating of bitumen and tars*

11.14.3.3.1 Tanks, vats, kettles, pots, drums and other vessels for heating tar, bitumen and other bituminous materials shall be,

a) adequately resistant to damage by heat, transportation, etc;
b) capable of holding a full load without danger of collapse, bursting or distortion;
c) provided with a close fitting cover suitable for smothering a fire in the vessel or protection from rain; and
d) leak proof, and provided with suitable outlets which can be controlled for taking out the hot material.

11.14.3.3.2 Suitable indicator gauges shall be used to ascertain level and temperature of the material in the boiler. On no account shall workers be allowed to peep into the boiler for this purpose. For ascertaining levels, in small plants, dipstick may also be used.

11.14.3.3.3 Gas and oil-fired bitumen and tar kettles or pots shall be equipped with burners, regulators and safety devices of types approved by the Authority. Heating appliances for vessels shall distribute the heat uniformly over the heating surface so as to avoid overheating. In case of bituminous mixtures using mineral aggregates filler together with bitumen, it is preferable to have some means for stirring as well. Only vessels heated by electricity shall be used inside buildings. Tar boilers shall never be used on combustible roof.

11.14.3.3.4 Buckets for hot bitumen, bituminous materials of tar shall have,

a) the bail or handle firmly secured; and
b) a second handle near the bottom for tipping.

11.14.3.3.5 Bitumen or tar boilers mounted on wheels for easy transport or towing shall preferably be provided with hand pumps for spraying purposes.

11.14.3.3.6 Vessels in operation shall be kept at a safe distance from combustible materials. When vessels are used in confined spaces, the gases, fumes and smoke generated shall be removed by exhaust ventilation or by forced ventilations. Vessels that are being heated shall not be left unattended. Pieces of bituminous material shall not be thrown into the hot vessels so as to cause splashing. Covers shall be kept closed when vessels are not in use. Containers shall not be filled with hot bitumen or tar to a level that might cause danger when they are carried or hoisted. Enough space shall be left in vessels for expansion of binder, when heated.

11.14.3.3.7 Bitumen/tar shall be kept dry and to avoid fire due to foaming, boiler shall have a device that prevents foam from reaching the burners or anti-foaming agents shall be used to control the same. Alternatively, to avoid fire due to foaming, the heating shall be at low temperature till the water entrapped, if any, is completely evaporated. Any water present in the boiler shall also be drained before using it for heating binders. No open light shall be used for ascertaining the level of binder in boilers. If a burner goes out, the fuel supply shall be cut off and the heating tube shall be thoroughly blown out by the fan so as to prevent a back fire.

11.14.3.3.8 Cutbacks shall not be heated over an open flame unless a water jacket is used. While they are being heated the vessel shall be kept open.

11.14.3.3.9 Piping shall not be warmed with burning rags and instead blow-lamps or similar devices shall be used.

11.14.3.3.10 Spilled bitumen or tar shall be promptly cleaned up around boilers.

11.14.3.3.11 Inspection openings shall not be opened while there is any pressure in the boiler.

11.14.3.3.12 When tanks are cleaned by steam, adequate precautions shall be taken to prevent any build up of pressure.

11.14.3.4 *Handling bitumen/tar*

Bitumen/tar shall not be heated beyond the temperature recommended by the manufacturer of the product. While discharging heated binder from the boiler, workers shall not stand opposite to the jet so as to avoid the possibility of hot binder falling on them. The container shall be handled only after closing the control valve. While handling hot bitumen/tar, workers shall exercise scrupulous care to prevent accidental spillage thereof. The buckets and cans in which the hot material is carried from boiler shall be checked before use to ensure that they are intact and safe. Mops and other applicators contaminated with bituminous materials shall not be stored inside buildings.

11.14.3.5 *Bitumen plants*

Safety requirements shall be in accordance with good practice [7(59)].

11.14.4 *Timber Structure*

Preventive measures against hazards in work places involving construction of timber structures shall be taken in accordance with good practice [7(60)].

11.15 Finishes

11.15.1 *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.

11.15.1.1 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.

11.15.1.2 A 5 kg dry powder fire extinguisher conforming to the accepted standard [7(61)] shall be kept handy.

11.15.1.3 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.

11.15.1.4 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 paint brushes shall be cleaned and deposited in the store along with the containers.

11.15.1.5 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.

11.16 Fragile Fixtures

It shall be ensured that sufficient number of workers 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.

11.17 Safety in Special Operations

Safety in compressed air work, drilling, blasting and welding operations shall be in accordance with good practices [7(62)].

11.18 Electrical Installations and Lifts

11.18.1 *Temporary Electrical Wiring*

11.18.1.1 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 they leave adequate head room.

11.18.1.2 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 3 kg/4.5 kg CO_2 extinguisher or one 5 kg dry powder extinguisher conforming to the accepted standard [7(61)] shall be provided near the switch board.

11.18.1.3 Requirements as given in **12** of Part 8 'Building Services, Section 2 Electrical and Allied Installations' of the Code shall also be complied with.

11.18.2 *Permanent Electrical Installations*

Besides the fire safety measures for electrical installations covered under **11.18.1**, safety in electric installations in buildings and installations of lifts shall be in accordance with **12** of Part 8 'Building Services, Section 2 Electrical and Allied Installations' of the Code, and Part 8 'Building Services, Section 5 Installation of Lifts, Escalators, Moving Walks and Parking Systems' of the Code, respectively.

11.19 General Safety Requirements for Workplace

11.19.1 *Sanitation*

a) Adequate 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.

11.19.2 *Fire Protection*

11.19.2.1 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.

11.19.2.1.1 All fire extinguishers shall be maintained in a serviceable condition at all times in accordance with good practice [7(42)] and all necessary guidelines regarding fire protection at workplaces followed in accordance with good practice [7(39)].

11.19.2.1.2 It shall be ensured that all workers and supervisory staff are fully conversant with the correct operation and use of fire extinguishers provided at the construction site.

11.19.2.1.3 Telephone number of local fire brigade should be prominently displayed near each telephone provided at construction site.

11.19.2.1.4 Watch and ward services should be provided at construction sites during holidays and nights.

11.19.2.2 Access shall be provided and maintained at all times to all fire fighting equipment, including fire hose, extinguishers, sprinkler valves and hydrants.

11.19.2.2.1 Approach roads for fire fighting should be planned, properly maintained and kept free from blockage. Width of approach road should be not less than 5 m to facilitate fire fighting operations.

11.19.2.2.2 Emergency plan and fire order specifying the individual responsibility in the event of fire should be formulated and mock drills should be practised periodically in case of large and important construction sites to ensure upkeep and efficiency of fire fighting appliances.

11.19.2.2.3 Periodical inspection should be carried out to identify any hazard and proper records maintained and follow up action taken.

11.19.2.2.4 Evacuation facilities and fire exits should be provided at all locations susceptible to fire hazards.

11.19.2.3 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 in **11.19.2.3.1** to **11.19.2.3.4**.

11.19.2.3.1 A stand pipe system (landing valves), permanent in nature shall be installed and made available before the building has reached the height of 15 m above the grade, and carried up with each floor.

11.19.2.3.2 The standpipe (landing valve/internal fire hydrant) and its installation shall conform to the accepted standards [7(63)].

11.19.2.3.3 The standpipe shall be carried up with each floor and securely capped at the top. Top hose outlets, should at all times, be not more than one floor below the floor under construction.

11.19.2.3.4 A substantial box, preferably of metal, should be provided and maintained near each hose outlet. The box should contain adequate lengths of hose to reach all parts of the floor as well as a short branch fitted with 12 mm or 20 mm nozzle.

11.19.2.4 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 m^2 on each floor.

11.19.2.5 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 1 000 m^2.

11.19.2.6 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.

11.19.2.7 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.

11.19.2.8 *Fire cut-offs*

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.

11.19.2.8.1 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.

11.19.3 *Clothing*

11.19.3.1 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.

11.19.3.2 Workers engaged in processes which splash liquid or other materials which will injure the skin shall have enough protective clothing to cover the body.

11.19.3.3 Individuals engaged in work involving use of naked flames (such as welding) shall not wear synthetic fibre or similar clothing which increases the risk of fire hazards.

11.19.4 *Safety Measures 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. For details as fall prevention reference may be made to good practice [7(64)].

11.19.5 *Falling Materials Hazard Prevention*

Preventive measures against falling materials hazards in work places shall be taken in accordance with good practice [7(65)].

11.19.6 *Disposal of Debris*

Preventive measures against hazards relating to disposal of debris shall be taken in accordance with [7(66)].

11.20 Construction Machinery

11.20.1 Specification and requirements of construction machinery used in construction or demolition work shall conform to accepted standards [7(67)].

11.20.2 For safety requirements for working with construction machinery, reference may be made to good practice [7(68)].

11.20.3 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.

11.20.4 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.

12 SAFETY IN DEMOLITION OF BUILDINGS

12.1 Similar to construction, safety in demolishing structures and buildings is an important concern and the associated engineers must be aware of the safety measures. The major hazards during demolition can be the disintegration of structure, uncontrolled or premature collapse, flying and falling material/debris impact on nearby structures, impact/hit/vibration created by material on the ground, machinery/equipment collapse, explosion, noise, dust, failed demolition of upper structure, fire, etc. Thus, well-planned and predetermined safety measures should be adopted to minimize the risk. The following control measures or procedures can be taken to reduce the risk:

a) A detailed engineering survey to identify the location of explosives.
b) Early removal of non-load-bearing walls and other building elements.
c) Analysing the structural integrity of adjoining buildings and providing adequate support and protection to the adjacent building.
d) Disconnection of all essential services including supply of electricity, water, gas, chemicals, fuel, telecommunications, and refrigerant in lines, etc as per municipal regulations.
e) Structural integrity and stability of the structure during all demolition stages.
f) Defining demolition sequence for stability.
g) Risk assessment and use of advanced technologies.

The safety requirements for carrying out demolition/dismantling work shall be as given in **12.2** to **12.31**.

12.2 Planning

12.2.1 Before beginning the actual work of demolition, a careful study shall be made of the structure which is to be pulled down and of all its surroundings.

12.2.2 It shall be ensured that the demolition operations do not, at any stage, endanger the safety of the adjoining buildings or their occupants or passers-by. Moreover, the adverse effect of the demolishing work on the use of the adjacent buildings shall be kept to the minimum.

12.2.3 During the demolition, 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.

12.3 Factors to be Considered Prior to Demolition

When selecting a demolition method, the following factors shall be taken into consideration:

a) The needs of the building owner, the client and the workmen.
b) Identifying the hazardous materials that could be generated during or after demolition and preparing methods for their safe disposal.
c) Information related to the structure, material used, electrical system, plumbing system, HVAC system, presence of hazardous chemicals if any, information on utilities, etc shall be collected.
d) Health, safety, and environmental regulatory requirements.
e) The type, age, condition, use and business activity (if appropriate) of the facility and local conditions and constraints (for example, access, existing services, party walls).
f) Potential for disruption to business continuity, the community and nearby structures.
g) Legislative requirements.
h) Wherever possible, details of the previous use should be obtained to identify any possible contamination and hazards from chemicals, flammables, etc.
j) All electric, gas, water drainage and communication service lines should be shut off and, as necessary, capped or otherwise controlled at or outside the construction site before work commences.
k) Tanks, pressure vessels and similar structures located within the demolition zone shall be identified and shall be evacuated through depletion, transfer to other storage, or venting or as per applicable good practice. With the exception of those designated for continued use that may be damaged by atmospheric exposure, tanks and vessels will be left open to the atmosphere once the contents have been evacuated.
m) Piping, tubing, compressors, pumps, hoists, and other equipment with refrigerants, oil or hydraulic fluid shall be identified and shall be drained completely by a licensed contractor. The contents will be captured, characterized, and transported as appropriate to a disposal or recycling facility.
n) Insurance and other incidental costs, and income from disposed materials, if any.

12.4 Site Survey

The contractor or other appointed party tasked with the demolition shall have a thorough knowledge of the site and shall be competent to assess and survey the site to check, manage and implement the following:

a) Extent of demolition;
b) Details of the isolation or removal of services and details of temporary utilities;
c) Knowledge and history of the structure, including configuration, materials of construction, structural interactions and location;
d) Isolation and protection measures for adjacent structures;
e) Presence of hazardous materials;
f) Previous uses of the site;
g) Possible presence of any overhead and underground services (example presence of tanks, pressure vessels, piping, tubing and other sensitive utilities) in and around the site that may be affected during demolition, with assistance sought from relevant authority as necessary;
h) To manage, contain and safely dispose of the contaminated water, if any, generated during the demolition process; and
j) Survey to identify the presence of piping, tubing, compressors, pumps, hoists, and other equipment with refrigerants, oil or hydraulic fluid shall be carried out.

12.5 Engineering Survey Report

An engineering survey report shall include the following:

a) Building characteristics (that is, construction type and structure size, height, structural hazards, enclosed/confined spaces, wall ties, shoring types and locations);
b) Modelling for collapse analysis, if required;
c) Protection for adjacent structures;
d) Methods for demolition;
e) Methods to protect the public;
f) Protection of utilities (overhead and underground);
g) Protection of above and below ground tanks;
h) Identifying hazardous material and methods for their safe disposal;
j) Blasting requirements; and
k) Training requirements.

12.6 Permissions, Consents and Licenses

Early consideration shall be given to ascertain whether any permissions, consents or permits/licenses are required for the demolition works and whether any special measures need to be put in place, particularly for works on dangerous structures or special sites (for example, nuclear, petrochemical or other hazardous industry sites or buildings) and for works which could:

a) Affect a public or private road, highway, rail line, waterway for example, works which necessitate:

    1) The partial or total closure of the road, highway, rail line or waterway;
    2) The erection of temporary structures (example, scaffolds, canopy, screens, hoardings and supports) on or over the road or highway;
    3) The use of plant or equipment on or over the road or highway; and

4) The storage of site vehicles on the road or highway.

b) Affect features outside the legal limits of the site (example, footway lights, vaults and other voids under a highway);
c) Affect access routes, for example, to an adjoining property or utilities;
d) Involve scaffolding or a crane jib passing over an adjoining property;
e) Involve the burning of waste on site;
f) Involve using explosives in demolition, for which local permissions from competent authorities shall be obtained; and
g) Affect utilities like power lines, gas, water supply etc, NOC shall be obtained from competent authority prior to demolition.

12.7 Health and Safety Plan

The contractor or other entity assigned the demolition shall follow good practice [7(13)] and prepare a health and safety plan, which shall include the following:

a) The sequence and method of demolition with details on means of access, working platform and plant and equipment requirements;
b) Specific details of and pre-weakening of structure or use of explosive;
c) Arrangements for the protection of persons employed on site and members of public;
d) Details of removal or making safe of electric, gas or other service;
e) Details on temporary service which are available or will be required;
f) Methods for dealing with flammable materials and gases which may remain from previous processes or storage, or may arise during the demolition;
g) Methods of determining the presence of hazardous substances, the means of disposal of such substance and the requirements for any protective equipment;
h) Arrangements for controlling transport used for the removal of waste;
j) Arrangements for controlling noise, dust and vibration generated prior, during and after demolition; and
k) Identifying persons with specific responsibilities for the control and co-ordination of safety arrangements.

12.8 Precautions Before Starting Demolition Work

12.8.1 On every demolition job, safety signages shall be conspicuously posted all around the site demolition area. Structure, all doors and openings giving access to the structure shall be kept barricaded or manned except during the actual passage of workmen or equipment. Provision shall be made for at least two independent exits for escape of workmen during emergency.

12.8.2 During nights, solar blinkers (at least 125 V; 55 W), LED rope light (at least 230 V; 36 W) or any other suitable means of red colour emitting lights shall be placed on all the barricades provided around the demolition sites. No demolition activity is permitted during night.

12.8.3 Where in any work of demolition it is imperative, because of inherent danger, to ensure that no unauthorized person shall enter the site of demolition outside working hours; a security person/unit shall be employed. In addition to watching the site, the person/unit shall also be responsible for maintaining all notices, lights and barricades.

12.8.4 All the necessary safety appliances shall be issued to the workers and their use explained. It shall be ensured that the workers use correctly all the safety appliances required for the work.

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

12.8.6 The power on all electrical service lines shall be shut off and all such lines cut or disconnected at or outside the property line, before the demolition work is started. Prior to cutting of such lines, the necessary approval shall be obtained from the electrical authorities concerned. The only exception will be any power lines required for demolition work itself. Alternatively, the implicated service lines may be moved away to sufficient distance until the task is completed. If both above options are not feasible, adequate protection against accidental contact such as rubber shielding shall be provided.

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

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

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

12.8.10 Protected walkways and passageways shall be provided for the use of the workmen who shall be instructed to use them and all such walkways and passageways shall be kept adequately lighted, free from debris and other materials.

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

12.8.12 Assistance shall be sought from relevant authority to deal with overhead and underground services in and around the demolition site.

12.8.13 Reduced voltage with a centre point earth connection, should be used where possible.

12.8.14 Temporary electrical supplies/service should be installed to the same standard as for other construction activities.

12.8.15 Where a supply is to be derived from street lighting systems, the permission of the appropriate supplier must be obtained and adequate precautions should be taken to avoid danger to the public at the main connections.

12.8.16 Where existing plant has contained flammable materials and gases, special precautions must be observed to avoid fire or explosion. The assistance of a competent analyst may be required to identify residues, carry out air monitoring and assess whether pockets of contamination remain. Any residual flammable materials and gases must be rendered safe by for example, cleaning, purging or the application of an inert gas.

12.8.17 Exclusion zone shall be demarcated and completely clear of any public access, allowing only authorized personnel to be present within. The size and boundary of the exclusion zone shall be determined on a case-by-case basis following a thorough risk assessment.

12.9 Protection to the Public

12.9.1 Before any demolition work is started, every footpath or road adjacent to the work likely to be affected shall be closed or protected, and alternatives provided for the diverted traffic.

12.9.2 Children and members of the public shall be kept out of the building and the adjoining yard.

12.9.3 If the structure to be demolished is more than two storeyed or 7.5 m high, measured from the footpath 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 with less a substantial footpath canopy (*see* Fig. 5) shall be constructed over the entire length of the footpath adjacent to the structure of sufficient width to protect pedestrian traffic on the footpath from falling debris or other materials. The footpath canopy shall be lighted sufficiently to ensure at all times. For detailed information reference may be made to good practice [7(69)]. A similar protected access route (access canopy) may also be used within the plot line of a demolition site depending on the requirement to enable protect the workers from any falling debris.

12.9.4 A toe board of at least 1 m high above the roof of the canopy shall be provided on the outside edge and ends of the footpath canopy. Such boards may be vertical or inclined outward at not more than 45°.

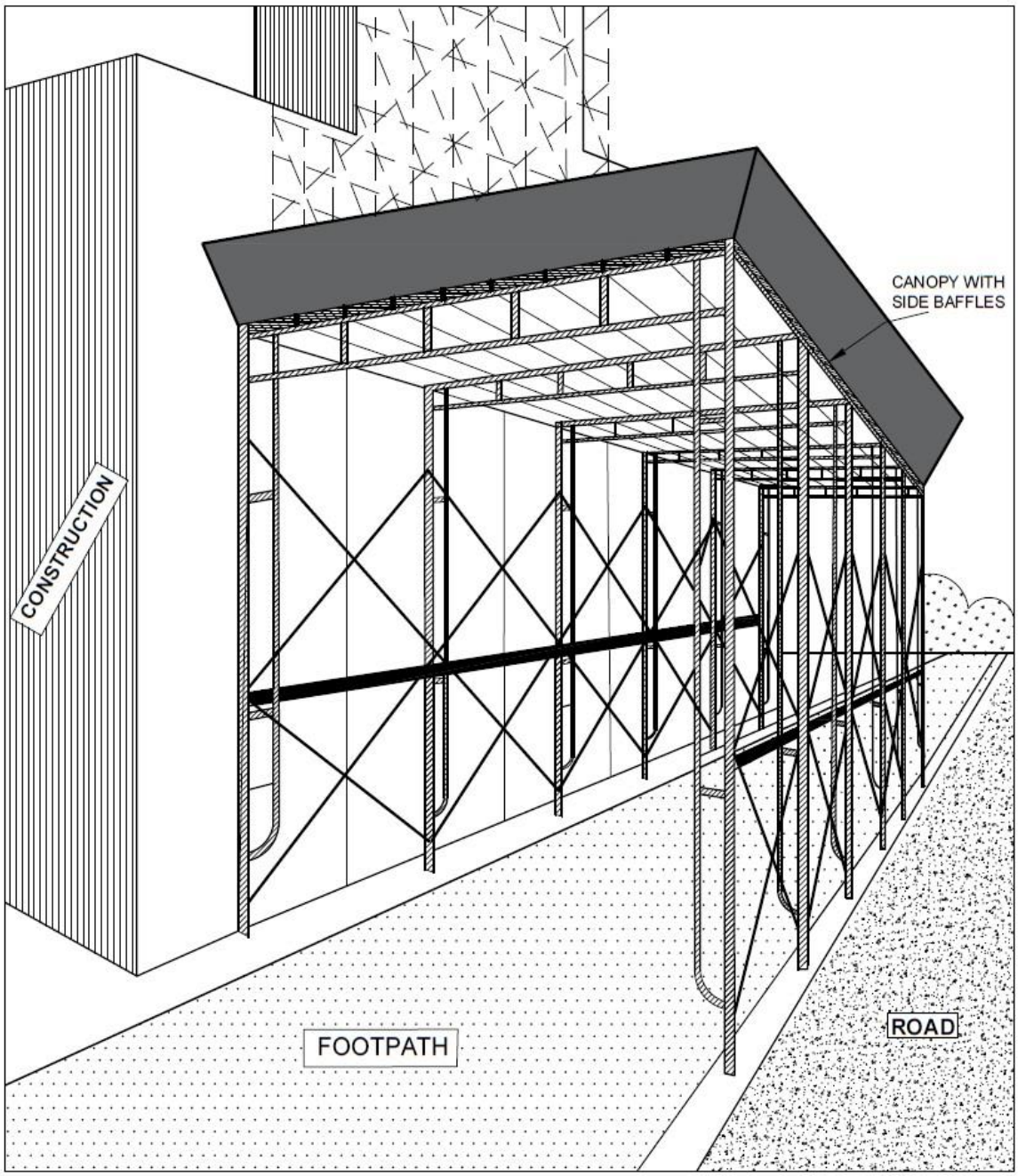


FIG. 5 TYPICAL SKETCH OF A SIDE CANOPY

12.9.5 Except where the roof of a footpath canopy solidly abuts the structure, the face of the footpath canopy towards the building shall be completely closed by providing sheeting planking to prevent falling material from penetrating into the canopy.

12.9.6 The roof of footpath canopy shall be capable of sustaining a load of 0.75 kN/m^2. Only in exceptional cases, say due to lack of other space, the storing of material on a footpath canopy may be permitted in which case the canopy shall be designed for a load of 1.50 kN/m^2. Roof of footpath canopy shall be designed considering 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 canopy is not more than 6 kN/m^2. The height of footpath canopy shall be such as to give a minimum clearance of 2.5 m.

12.9.7 Any opening in the canopy for personnel or deliveries access shall be kept closed at all time except during actual loading operations.

12.9.8 The deck flooring of the footpath canopy shall consist of plank of not less than 20 mm in thickness closely laid and deck made watertight. All members of the canopy shall be adequately braced and connected to resist displacement of members or distortion of framework.

12.9.9 When the horizontal distance from the inside of the footpath to the structure is more than 4.5 m and less than 7.5 m, a footpath canopy or fence may be built or in place of such a canopy or fence a substantial railing shall be constructed on the inside of the footpath or roadway along the entire length of the demolition side of the property with access gates as may be necessary for the proper execution of the work.

12.9.10 Where worker's entrances to the building being demolished are not completely protected by footpath canopies, all such entrances shall be protected by canopies extending from the face of the building to a point not less than 2.5 m from it. Such overhead protection shall be at least 0.6 m wider than the building entrance or opening and every canopy shall be as strong as the footpath canopy, specified in **12.9.6**.

12.10 Sequence of Demolition Operations

12.10.1 The demolition work shall proceed with, in such a way that:

a) it causes the least damage and adverse effect on adjoining buildings and the members of the public; and
b) it satisfies all safety requirements enumerated in **12** of the Code.

12.10.2 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.

12.10.3 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.

12.10.4 All well openings which extend down to floor level shall be barricaded to a height of not less than one metre above the floor level. This provision shall not apply to the ground level floor.

12.10.5 All floor openings and shafts not used for material chutes shall be floored over and be enclosed with guard rails and toe boards.

12.10.6 The demolition shall always proceed systematically storey by storey in descending order and the work on the upper floors shall be completely over before any of the supporting members or other important portion on the lower floor is disturbed. These requirements shall not prohibit the demolition of structure in sections, if means are taken to prevent injuries, to persons or damage to property.

12.11 Removal of Materials

12.11.1 *General*

Dismantled materials may be thrown to the ground only after taking adequate precautions and as per good practice [7(66)]. The material shall preferably be dumped inside the building. Normally such materials shall be lowered to the ground or to the top of the footpath canopy where provided by means of ropes or suitable tackles. (see also **12.9.6**).

12.11.2 Through Chutes

12.11.2.1 Wooden, metal or plastic chutes may be provided for disposal of materials. The chutes shall preferably be provided at the centre of the building, or, if more than one, appropriately distributed along its width for efficient disposal of debris.

12.11.2.2 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.

12.11.2.3 Opening for the chutes (*see* **10.11.3**) shall not exceed 1.20 m in height measured along the wall of the chute and in all storeys below the top floor such opening shall be kept closed when not in use.

12.11.2.4 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 stop shall be provided with suitable means for closing at the bottom of each chute to stop the flow of materials.

12.11.2.5 Chute at an angle of less than 45° to the horizontal may be left open on the upper side provided that at the point where such a chute discharges into a chute steeper than 45° to the horizontal, the top of the steeper chute shall be boarded over to prevent the escape of materials.

12.11.2.6 The chutes shall end into a metal bin for easy disposal and less dust.

12.11.2.7 Any opening into which workmen dump debris at the top of chute shall be guarded by a substantial guard rail extending at least one metre above the level of the floor or other surface on which men stand to dump the materials into the chute.

12.11.2.8 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 wheelbarrows. Any space between the chute and the edge of the opening in the floor through which it passes shall be solidly planked over.

12.11.2.9 The chute should be equipped with a water sprinkler system to control dust.

12.11.2.10 Rotational water guns should be provided at the ground floor waste collection point to control dust.

12.11.3 *Through Holes in the Floors*

12.11.3.1 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 unless the lateral supports of the removed flooring remain in place. It shall be ensured that the storage floor is of adequate strength to withstand the impact of the falling material.

12.11.3.2 Openings in all the floors below the floor from which materials are being removed, shall be protected by standard railings and toe boards or preferably planked over when the holes are not being used for dumping materials.

12.11.3.3 All intermediate floor openings for passage of materials shall be completely enclosed with barricades or guard rails not less than 1m high and at a distance of not less than one metre from the edge of general opening. No barricades or guard rails shall be removed until the intermediate floor in question is itself ready for demolition and all debris cleared from the floor.

12.11.3.4 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.

12.11.3.5 Opening at grade level shall be kept to the minimum size in order not to weaken the structure. Professional engineer maybe consulted if a larger opening is required.

12.11.4 *Removal of Debris*

12.11.4.1 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.

12.11.4.2 The debris 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 debris heap shall be limited to ensure its not toppling over or otherwise endangering the safety of workmen or passers-by.

12.11.4.3 The debris shall be removed from the demolition site to a final disposal or recycling location as required by the local bodies or civil authorities. Depending on the space available at the demolition site, this operation of conveying debris to its final disposal location or recycling 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 debris has been carried to its final disposal location or recycling location and the demolition area cleaned up.

12.11.4.4 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 suitably covered. Such materials shall be covered during transportation also.

12.11.4.5 Materials from demolition which are likely to include asbestos, lead or other hazardous materials shall be collected with workers wearing appropriate PPE, bagged separately and disposed of safely complying with local regulation.

12.11.4.6 Unauthorized use of the debris from any work shall not be permitted. The released materials classed as 'serviceable' shall be inspected by a competent person before being used.

12.11.4.7 The foreman should determine when debris is to be removed, halt all demolition during debris removal, and make sure the area is clear of clean-up workers before continuing demolition.

12.11.4.8 If debris is dropped inside the shaft, it can be removed through an opening in the structure at grade level.

12.11.4.9 When the debris is removed at the bottom of the shaft, the personnel involved, whether manually or by machine, shall be suitably protected from falling debris and other incidental physical and chemical hazards.

12.11.4.10 Do not allow excessive debris to accumulate inside or outside the shaft of the chute as the excess weight of the debris can impose pressure on the wall of the structure and might cause the shaft to collapse.

12.12 Stairs, Passageways and Ladders

12.12.1 Stairs and stair railings, passageways and ladders shall be left in place as long as possible.

12.12.2 For the use of ladders, provisions laid down in good practice [7(57)] shall be followed.

12.12.3 All stairs, passageways and ladders to be used by workmen during the process of demolition shall be maintained in a safe condition.

12.12.4 Ladders or their side rail extend not less than 1.0 m above the floor or platform to which such ladder gives access.

12.12.5 All ladders shall be secured against, slipping out at the bottom and against movement in any direction at the top.

12.13 Demolition of Walls

12.13.1 Top-down methodology shall be adopted, that is; demolishing from the top floor level progressively floor by floor, down to ground, with an exception wherever demolition methodology is engineered and designed otherwise.

12.13.2 While walls or 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 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 to prevent any possible unexpected collapse of the floor.

12.13.3 Walls shall be removed part by part. Stages shall be provided for the men to work on, if the walls are very thin and dangerous to work by standing over them.

12.13.4 No section of wall whose height is more than 15 times of thickness, shall be permitted to stand without lateral bracing unless such wall is in good condition and was originally designed to stand without such lateral bracing or support.

12.13.5 Structural or load supporting members on any floor shall not be cut or removed until all the storeys above that floor have been demolished and removed.

12.13.6 Before demolishing any interior or exterior wall within 3 m of the opening in the floor immediately below, such opening shall be substantially planked over, unless access is denied to workmen to that portion of the area of the floor immediately below the opening, in the floor of the storey being demolished, where any debris pieces passing through this opening may fall.

12.13.7 In framed structures, the steel frame may be left in place during demolition of masonry work. Where this is done, all steel beams, girders, etc, shall be cleared of all loose materials as the demolition of masonry work progress downward provided it is still strong enough to stand as an independent structure.

12.13.8 Walkways shall be provided to enable workmen to teach or leave their work on any scaffold or wall. Such walkways shall be not less than 3 planks, nor less than 0.8 m in width.

12.13.9 At the completion of each day's work, all walls shall be left stable to avoid any danger of getting overturned.

12.13.10 Foundation walls which serve as retaining walls to support earth or adjoining structure, shall not be demolished until such an adjoining structure has been underpinned or braced and the earth removed by sheet piling or sheathing.

12.13.11 Demolition work shall be suspended in case of adverse weather condition.

12.13.12 Do not use walls which serve as retaining walls against which debris will be piled unless they can support the imposed load.

12.13.13 Dismantle steel construction, column length by column length, and tier by tier. For detailed information reference may be made to good practice [7(69)].

12.14 Manual Demolition of Roofs

During the manual demolition of the roofs following shall be considered:

a) Fall hazards;
b) Structural stability;
c) Condition and strength of the roofing material and the identification of fragile roofing;
d) Identification of fragile panels or skylights in solid roofs;
e) Crane access;
f) Safe worker access and egress;

g) Fall protection requirements including issues such as perimeter protection, the availability and strength of anchor points for static lines, inertia reels and lanyards and the suitability of roof structure for the use of safety nets;
h) Means of rescuing persons from safety nets or safety harness;
j) The condition of any roof mesh or safety mesh;
k) Methods of raising and lowering equipment and materials;
m) Assessment of manual handling problems;
n) Electrical safety including the location of nearby power line; and
o) Worker competency and training needs.

12.15 Demolition of Floors

12.15.1 In cutting holes in a floor which spans in one direction, a slit of width not exceeding 300 mm shall be cut at the first stage for the entire length of the slab along which it spans (*see* Fig. 6). The opening shall thereafter be increased.

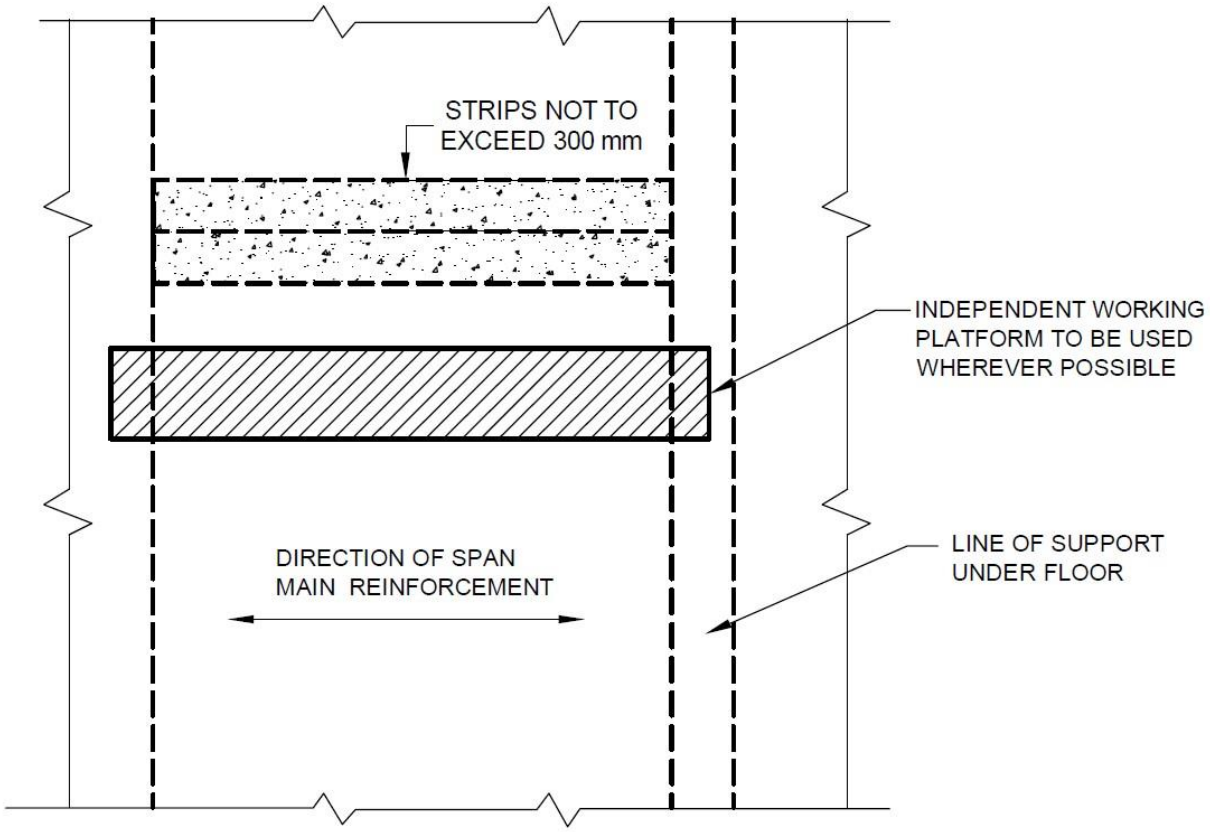


FIG. 6 PLAN VIEW OF DEMOLITION OF REINFORCED CONCRETE FLOORS

12.15.2 Planks of sufficient strength of thickness not less than 50 mm and 250 mm width shall be provided at spacing not greater than 400 mm for the workmen to work. The length of planks shall not be less than 2 000 mm. These planks shall be so placed as to give workmen trim support to guard against any unexpected floor collapse.

12.15.3 Stringers of ample strength shall be installed to support the planks where necessary and the ends of such stringer shall be supported by floor beams, girders and not by floor slab alone.

12.15.4 When floors are being removed, no workmen shall be allowed to work in the area, directly underneath and such area shall be barricaded to prevent access to it.

12.15.5 The demolition of floor shall be started only after the floor in question and the surrounding floor area for a distance of 6.0 m have been entirely cleared of persons, and the debris and other unnecessary material removed.

12.15.6 Planks used for temporary protection shall be sound and at least 50 mm thick. They shall be laid close together with the ends having at least 100 mm bearing over solid support to prevent tipping under load. If corrugated GI sheets are used for temporary protection, it shall be secured to the solid support with suitable framework.

12.16 Demolition of Steel Structures

12.16.1 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.

12.16.2 Overloading of equipment shall not be allowed.

12.16.3 Tag lines shall be used on all materials being lowered or hoisted up and a standard signal system shall be used and the workers instructed on the signals.

12.16.4 No person shall be permitted to ride the load line.

12.16.5 No beams shall be cut until precautions have been taken to prevent it from swinging freely and possibly striking any worker or equipment or to any part of the structure being demolished.

12.16.6 All structural steel members shall be lowered from the building and shall not be allowed to drop.

12.16.7 Steel construction should be demolished tier by tier.

12.17 Catch Platform

12.17.1 In demolition of exterior wall of multi-storeyed structure, it is advisable to provide catch platform of heavy planking to prevent injuries to the worker working below and to the public, when the external walls are more than 20 m in height.

12.17.2 Such catch platform shall be constructed and maintained not more than 3 storeys below the storey from which exterior wall is being demolished. When demolition has progressed to within 3 storeys of ground level, catch platform will not be considered necessary.

12.17.3 Catch platforms shall not be less than 1.5 m in width, measured in a horizontal direction from the face of the structure and shall consist of outriggers and planks. Planks shall be laid tight together, without openings between them and the walls. Catch platform shall be provided with a continuous solid parapet along its outer edge of at least 1 m height. The parapet shall be constructed of the same specification as the platform.

12.17.4 Catch platform can be constructed of material other than wood also, provided such material is of equal or greater strength.

12.17.5 Catch platform shall be capable of sustaining a live load of not less than 6.1 kN/m^2.

12.17.6 The outriggers shall be of ample strength and shall not be spaced more than 3 m apart.

12.17.7 Materials shall not be dumped on catch platform nor shall such catch platform be used for the storage of materials.

12.18 Mechanical Demolition

12.18.1 When demolition is to be performed by mechanical devices, such as weight ball and power shovels, the following additional precautions may be observed other than the individual procedures mentioned in different clauses and the procedures mentioned in good practice [7(68)]:

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 located so as to avoid contact with power line, falling debris, etc that may damage the device; and
d) The mechanical device when being used shall not cause any damage to adjacent structure, adjacent utilities, power line, etc.

12.18.2 Mechanical Demolition of RCC Structure/Steel Structure/Brickwork

Excavator mounted hydraulic concrete crusher may be used for demolishing RCC or brick structures, this is classified as ‘silent demolition’ as it generates no vibration and with very low noise while the demolition is carried out;

a) For demolition of steel structures special steel shears maybe used;

b) For crushing concrete or cutting structural steel or crushing brick masonry hydraulic powerful attachments shall be used;

c) Demolition shall be started from topmost slabs of the RCC structure and proceed inwards into the building;

d) If a swinging weight is used for demolition, a safety zone having a width of at 1.5 times the height of the building or structure shall be maintained as exclusion zone;

e) Swinging weights should be so controlled such that they cannot swing against any structure other than the one being demolished;

f) Only mechanical lattice boom crane shall be used for demolition using swinging weight; and

g) If a clamshell bucket is used for demolition handling, a safety zone extending 8 m from the line of travel of the bucket should be maintained.

12.18.3 Few of the machinery that are used in demolition work are mentioned below:

a) Jack hammer machine;
b) Diamond cutters;
c) Static hydraulic splitter;
d) Magnetic induction heating breaker;
e) Hydraulic crusher;
f) Hydraulic breaker;
g) Steel shear;
h) Demolition ball machine;
j) Hydraulic pusher arm; and
k) Robotic machines

12.19 Recommendations for Demolition of Certain Special Types and Elements of Structures

12.19.1 *Roof Trusses*

12.19.1.1 If a building has a pitched roof, the roof 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.

12.19.1.2 Temporary bracing 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.

12.19.1.3 On no account should the bottom tie of roof trusses be cut until the principal rafters are prevented from making outward movement.

12.19.2 *Heavy Floor Beams*

Heavy baulks of timber and steel beams should be supported before cutting at the extremities and should then be lowered to a safe working place.

12.19.3 *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. Particular care should be exercised and full examination of this type of structure undertaken before demolition is commenced (*see* Fig. 7). The floor should be demolished in strips parallel to the span of the arch rings at right angles to the main floor beams.

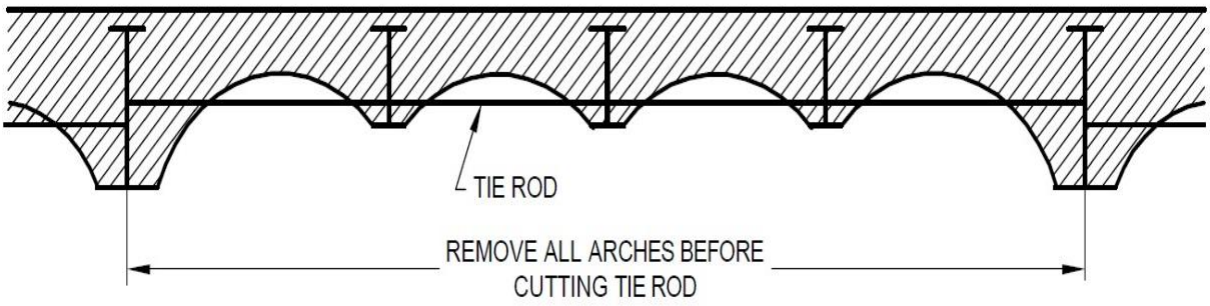


FIG. 7 DEMOLITION OF JACK ARCHES

12.19.4 *Brick Arches*

12.19.4.1 Expert advice should be obtained and, at all stages of the demolition, the closest 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.

12.19.4.2 As much dead load as possible may be removed provided it does not interfere with the stability of the main arch rings but it should be noted that the load-carrying capacity, of many old arches rely on the filling between the spandrels. 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.

12.19.4.2.1 The normal sequence of demolition is as shown in Fig. 8A, namely:

a) Remove spandrel after filling down it to the springing line;
b) Remove the arch rings; and
c) Remove the abutment.

12.19.4.2.2 Special temporary support shall be provided in the case of skew bridges.

12.19.4.3 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 (*see* Fig. 8B). Where it is impossible to allow debris to fall to the ground below, centring designed to carry the load should be erected and the arch demolished progressively. The design of the centring should make appropriate allowance for impact.

12.19.4.4 Where deliberate collapse is feasible the crown may be broken by the demolition ball and working progressively from edges to the centre (*see* Fig. 8C).

12.19.4.5 Collapse of the structure can be affected in one action by the use of explosives. Charges should be inserted into boreholes drilled in both arch and abutments. This method is the most effective for demolition of tall viaducts.

12.19.4.6 In multi-span arches before individual spans are removed, lateral restraint should be provided at the springing level. Demolition may then proceed as for a single span, care being taken to demolish the spandrels down to the springing line as the work proceeds (see Fig. 8D). 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 portions standing.

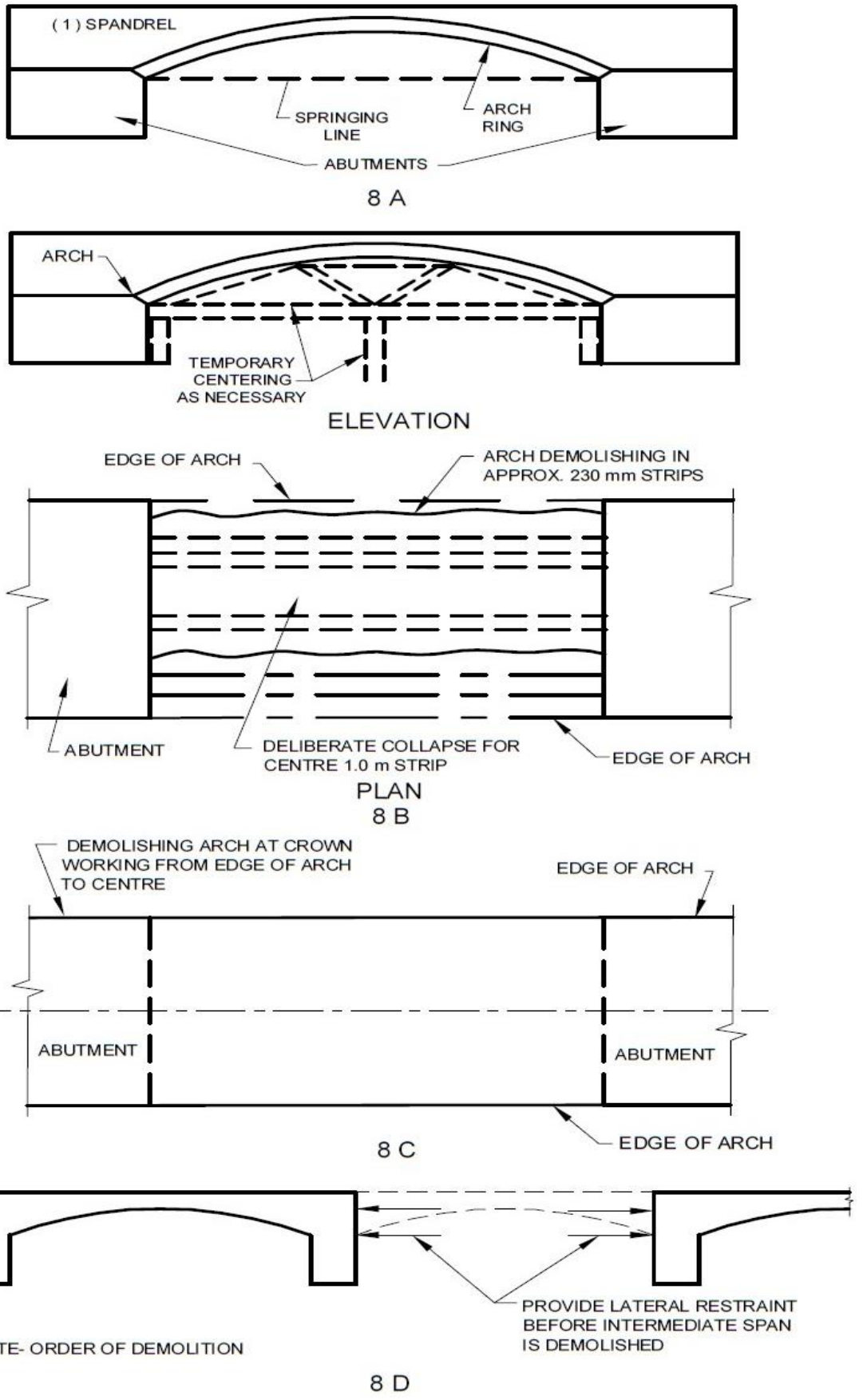


FIG. 8 DEMOLITION OF MASONRY AND BRICKWORK ARCHES

12.19.5 *Cantilever (Not Part of a Framed Structure)*

A cantilever type of construction depends for its stability on the superimposed structure. Canopies, cornices, staircases and balconies should be demolished or supported before tailing down, load is removed.

12.19.6 *In-situ Reinforced Concrete*

12.19.6.1 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.

12.19.6.1.1 Attention should be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability.

12.19.6.2 Demolition should be commenced by removing partitions and external non-load bearing cladding. It should be noted that in some buildings the frame may rely on the panel walls for stability.

12.19.6.2.1 Where manual demolition methods are to be used, the following procedures should be used:

a) *Reinforced Concrete Beams* — For 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 (*see* Fig. 9A).

b) *Reinforced Concrete Columns* — For 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 the column to be pulled down to the floor under control (*see* Fig. 9B for sequence of operations).

c) *Reinforced Concrete Walls* — Reinforced concrete walls should be cut into strips and demolished as for columns (*see* Fig. 9C).

d) *Suspended Floors and Roofs* — Before demolishing suspended floors and roofs, the type of construction should be ascertained. In solid slabs, the direction of the main reinforcement should be determined; the slab should then be cut into strips parallel to the main reinforcement and demolished strip by strip (*see* **12.15** and Fig. 6). 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.

12.19.7 *Precast Reinforced Concrete*

12.19.7.1 Precast reinforced concrete units used in a structure are normally held in position by the strength of the joints made in-situ or on supporting walls, etc. As such, before starting on demolition, the joint structures and/or the supporting mechanisms shall be studied and understood.

12.19.7.2 In devising and following the demolition sequences due precaution shall be taken to avoid toppling over of prefabricated units or any other part of the structure and wherever necessary temporary supports shall be provided.

12.19.8 *Prestressed Reinforced Concrete*

12.19.8.1 Prestressed concrete structures will have very high internal stresses locked into them by the high tension in the steel tendons or bars inside. Sudden release of the tension due to demolition may lead to catastrophic consequences, and hence expert attention will be needed.

12.19.8.2 *Pre-stressed concrete structures*

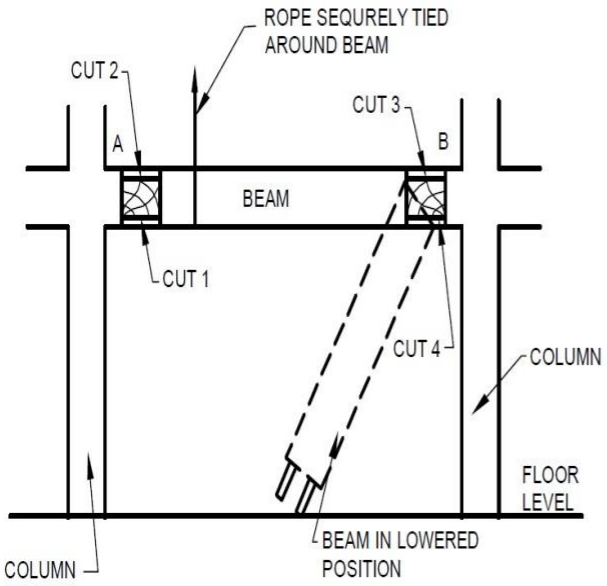
The most important aspect of demolishing a pre-stressed concrete structure takes place during the engineering survey. During the survey, a qualified person shall determine if the structure to be demolished contains any pre-stressed members.

It is the responsibility of the demolition contractor to inform all workers on the demolition job site of the presence of pre-stressed concrete members within the structure. They should also instruct them in the safe work practice which must be followed to perform the demolition safely. Workers should be informed of the hazards of deviating from the prescribed procedures and the importance of following their supervisor's instruction.

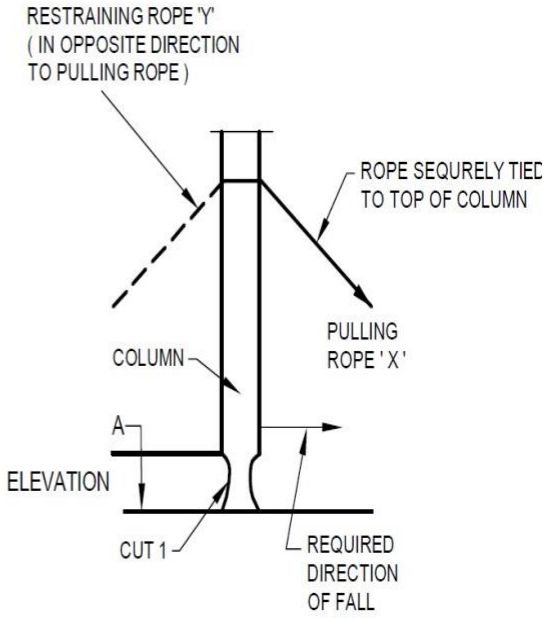
12.19.8.3 *Pre-tensioned members*

Pre-tensioned members usually do not have any end anchors, the wires being embedded or bonded within the length of the member. The following shall be noted before demolition of pre-tensioned members:

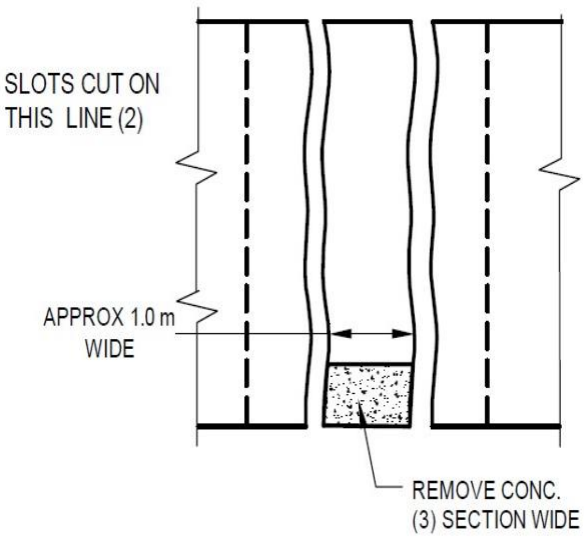
a) Before demolition of prestressed or post-tensioned member the internal locked in stresses should be neutralised;
b) Advice of a structural expert should be taken;
c) Demolish simple pre-tensioned beams and slabs of spans up to about 7 m in a manner similar to ordinary reinforced concrete;
d) Lift and lower pre-tensioned beams and slabs to the ground as complete units after the removing composite concrete covering to tops and ends of the units;
e) Turn the members on their sides to facilitate breaking up;
f) Lift the structure from points near the ends of the units or from lifting point positions A (*see* Fig. 9);
g) Whenever possible, reuse lifting eyes if they are in good condition; and
h) When units are too large to be removed, consider temporary supporting arrangements.



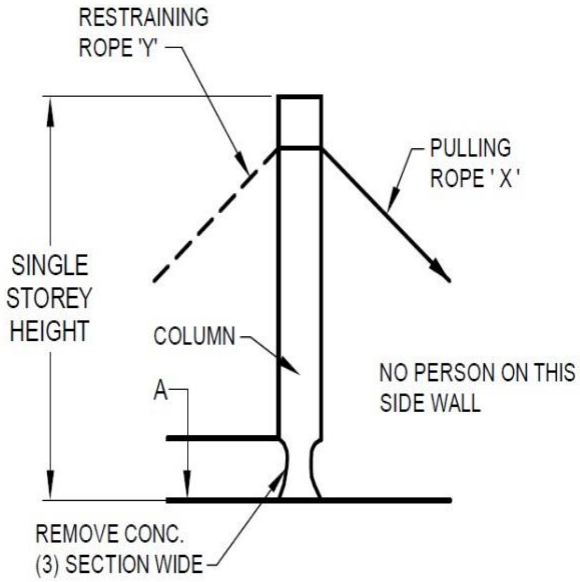
9A R C BEAMS



9 B R C COLUMNS



9C R C WALLS



9D R C COLUMN CONCRETE

FIG. 9 MANUAL DEMOLITION OF IN-SITU CONCRETE STRUCTURE

12.19.9 *Precast Units Stressed Separately*

Before breaking up precast units stressed separately from the main frames of the structure, they should be lowered to the ground, if possible. It is advisable to seek the counsel of a professional engineer before carrying out this work, especially where there are ungrouted tendons. In general, this is true because grouting is not always 100 percent efficient. The following shall be noted before such kind of demolition:

a) After lowering, units can be turned on their side with the ends up on blocks after any composite concrete is removed. This may suffice to break the unit and release the prestress; if not, erect a sand bag screen, timbers, or a blast mat as a screen around the ends;

b) Clear the area of any personnel; and

c) Remember the end blocks may be heavily reinforced and difficult to break up.

12.19.10 *Monolithic Structures*

A monolithic structure is something carved or cast from a single piece of a material. Usually (and literally, from the translation of monolith being 'one stone') the material is stone, but it could equally be applied to a structure cut from a single block of metal or cast in metal in a single piece. Most domed structures, like sports stadiums, are considered monolithic.

The advice of the professional engineer experienced in pre-stressed work should be sought before any attempt is made to expose the tendons or anchorages of structures in which two or more members have been stressed together. The following shall be noted before such kind of demolition:

a) It will usually be necessary to provide temporary supports so that the tendons and the anchorage can be cautiously exposed; and

b) Do not indiscriminately attempt to expose and de-stress the tendons and anchorages

12.19.11 Chimney and Spires

12.19.11.1 Before commencing of the demolition work, involving such structures, advice of an engineer expert in such demolition shall be obtained and followed.

12.19.11.2 The following shall be considered at the time of demolition of tall chimneys:

a) Tall chimneys should not be demolished by blasting or overturning unless a protected area of adequate dimensions can be established in which the chimney can fall safely;
b) Tall chimneys should only be demolished by competent persons under constant competent supervision.
c) Workers should not stand on top of the chimney wall; and
d) Material thrown down should only be removed during breaks in the work or under controlled conditions

12.20 Blasting Methods

12.20.1 *General Principles of Blasting Methods*

Usually, concrete blasting is done using small confined explosive charges which are placed in drilling holes. Single, double or triple rows are used in the case of linear cuts of a structure or the demolition of columns, beams, walls, etc. If the demolition purpose is to create total fragmentation in the concrete or part of the structure, for instance when

blasting foundations, apartments, opening, etc. The procedure is to arrange a pattern of holes in a grid with equal distance between the holes.

The explosive charges are normally ignited by millisecond delay detonators (generally time of delay is a multiple of 20 milliseconds to 30 milliseconds) and special consideration is paid to the safety, if the surroundings and remaining structure, just as the optimal use of the explosive energy is ensured.

Calculation of blasting charges have always been based on empiric formula and the personal experience of the individual blaster. A basic starting point for charge calculation is to determine the average specific charge for the object. The Table 4 shows an example of empiric specific charges.

Table 4 Empiric Specific Charges
(Clause 12.20.1)

Sl No.	**Object**	**Specific Charge** kg/m^3	**Hole Spacing** m
(1)	(2)	(3)	(4)
i)	Concrete and masonry, poor quality	0.15 to 0.40	0.70 to 0.80
ii)	Concrete and masonry, good quality	0.30 to 0.40	0.60 to 0.70
iii)	Reinforced concrete, normal	0.40 to 0.60	0.40 to 0.50
iv)	Reinforced concrete, heavy	0.60 to 1.50	0.30 to 0.50
v)	Reinforced concrete, heavy, high, concrete strength	1.50 to 2.00	0.25 to 0.50

12.20.2 *Controlled Blasting*

Controlled or careful blasting of concrete is a technique which is based on the same principles as modern rock blasting, using a minimum of explosives, to control the unwanted effect of the explosives and to prevent damage to the surroundings.

The control of blasting operations is made possible by using divided charges in densely drilled holes ignited at short time intervals normally 20 milliseconds to 30 milliseconds. The desired definitive effect can hereby be obtained and unintended effects reduced.

12.20.3 *Implosion*

Implosion, a specialized demolition technique employed for tall structures, involves strategically placing explosives at predetermined locations within the building. These explosives are then carefully detonated in a meticulously designed sequence, ensuring precise control over the direction of the collapse and its impact on the ground.

This method of demolition shall be carried out exclusively by experts well versed in the intricacies of explosives and structural dynamics.

12.20.4 In general ground vibration during implosion shall be restricted to peak particle velocity (PPV) to less than 25 mm/s to adjacent structure closest to the structure being demolished.

12.21 Environment Management

Demolition activity can create impact to environment in different manner which could be managed by assessing and taking adequate precautionary measures as follows:

a) Control of noise at the site boundaries;
b) Control of dust emissions;
c) Waste management (*see* **12.21.1**);
d) Minimizing of materials haulage;
e) Bunding arrangements for storage and dispensing of fuel oils;
f) Wheel washing plant and road-cleaning arrangements, where required;
g) Skip or truck sheeting arrangements;
h) Arrangements for dealing with hazardous materials, that is Flammable materials; gases, hazardous liquids and asbestos;
j) Anticipated values of air overpressure and ground vibration;
k) Areas of conservation, including flora and fauna; and
m) Minimizing landfill.

12.21.1 *Construction and Demolition Waste Management*

12.21.1.1 Construction and Demolition (C&D) waste management plan shall be submitted to the Authority for approval by all C&D waste generators and service providers (authorities who provide services like water, sewerage, electricity, telephone, roads, drainage, etc, and often generate construction and demolition waste during their activity, which includes excavation, demolition and civil work) with plot sizes greater than or equal to 500 m^2. The plan shall specify the following (*see* Annex B):

a) Estimation of quantity of C&D waste generation,
b) Storage and segregation,
c) Reuse and recycle on site,
d) Collection and transportation,
e) Processing facility,
f) Record keeping, and
g) User charges.

12.21.1.2 General guidelines for C&D waste management that are listed in **12.21.1.1** as specified in Table 5 shall be followed.

Table 5 Requirements for C&D Waste Management
(*Clause* 12.21.1.2)

<table>
<tr><th>Sl No.</th><th>Parameters</th><th>Requirements</th></tr>
<tr><td>(1)</td><td>(2)</td><td>(3)</td></tr>
<tr><td>i)</td><td>Estimation of quantity of Cand D waste generation</td><td>a) Quantity and composition of the C&D waste generated in building plan shall be assessed to plan measures for effective storage, collection and transportation of C&D waste.
b) Proper assessment of the quantum of C&D waste generated shall determine the processing methods and technologies that may be adopted, and the products that may be manufactured out of recycled C&D waste.
c) The quantity of C&D waste may be calculated using the Technology Information, Forecasting and Assessment Council (TIFAC) thumb rule as specified in below. The total built-up area of construction, demolition and renovation may be multiplied by the TIFAC thumb rule to obtain an approximate waste generation estimate for the layout plan.
<table>
<tr><th>Type of Activity</th><th>Estimated Waste Generation kg/m^2</th></tr>
<tr><td>Construction</td><td>50</td></tr>
<tr><td>Demolition</td><td>400</td></tr>
<tr><td>Renovation</td><td>45</td></tr>
</table></td></tr>
<tr><td>ii)</td><td>Storage and segregation</td><td>a) C&D waste shall be stored separately within the site. Other wastes such as municipal solid waste, e-waste, etc shall not be mixed with C&D waste.
b) C&D waste shall be stored in appropriate areas to protect waste from deterioration from rain or sunshine. C&D waste that may be degraded by mud or dust shall be stored away from heavy traffic areas.
c) Segregation, storage and stockpiling locations shall be clearly sited on the layout plans. The area demarcated in the plan shall be in proportion to the estimated C&D waste generated.
d) RBP shall be responsible for compliance of C&D waste management plan.
e) Hazardous waste on the C&D site shall be segregated in a proper manner and stored in a designated location. The C&D waste management plan shall consider measures for safe disposal of any hazardous waste in the site. In case of a demolition site, waste generator shall remove the</td></tr>
</table>

Sl No.	Parameters	Requirements
(1)	(2)	(3)
		hazardous waste safely and systematically prior to demolition. f) Hazardous waste shall be safely stored, in clearly labelled containers, out of reach of unauthorized persons. Proof shall be maintained that the waste is transferred to a facility that is authorized to receive it.
iii)	Reuse and recycle on site	a) Waste generators may reuse and recycle the C&D waste generated on-site. C&D waste may either be recycled on-site into new construction resources or off-site at a recycling plant. b) Waste generator shall use, to the extent possible, C&D waste generated on site after due process as a backfilling material. C&D waste may also be used in applications such as in filler material in roof construction, wall decorative chips, etc, subject to strict quality control. c) Waste generator may reuse and recycle C&D waste using the end use processes. (*see* Annex C). d) C&D waste may be supplied to nearby projects at mutually agreed terms and conditions for reuse/recycling. e) Municipal and government contracts may use to a minimum of 10-20 percent recycled C&D materials in their project. This shall be subject to strict quality control.
iv)	Collection and transportation	a) The collected C&D waste shall be stored within the site. There shall be no littering or deposition of C&D waste to prevent obstruction to the traffic, public or drains. b) Transportation of C&D waste shall be done only in covered vehicles to prevent dust pollution. c) C&D waste, that is not reused, recycled or processed on site, shall be transported by the waste generator on their own or through authorized private agencies. The waste shall be deposited at designated collection centres or processing plants.
v)	Processing facility	a) C&D waste may be processed using any of the following methods: 1) C&D waste generator shall pay for waste to be processed at a dedicated processing plant set up by the local Authority. 2) C&D waste generators who generate more than 1 lac t of C&D waste shall process the waste material in-situ and shall use the produce/downstream products in the same project.

Sl No.	Parameters	Requirements
(1)	(2)	(3)
		3) Mobile C&D waste processing plants, that perform segregation and waste crushing related activities, may be set up for projects generating smaller quantities of C&D waste. b) Operator of the C&D waste processing facilities for both public and private plants shall follow the guidelines and regulations as specified in the C&D Waste Management Rules, 2016, as amended from time to time. c) Companies in the construction industry may set up their own private C&D waste processing plants to cater to the waste generated from various projects as well as cater to the C&D waste market on a commercial basis.
vi)	Record keeping	a) Records shall be maintained for all C&D waste which has been generated on-site, and which may be reused, recycled and processed or transported to a different location. The format for record keeping of C&D waste shall be as per Annex D. The following details shall be recorded: 1) on-site processing details of C&D waste; 2) course of action for reuse; 3) waste taken for reuse off-site; 4) reclaimed waste materials brought on-site for reuse; and 5) waste taken for disposal. b) A copy of the C&D waste management plan shall be also kept at the site for verification by the Authority.
vii)	User charges	a) Based on the estimated quantity of C&D waste generated, waste generator shall pay relevant charges for collection, transportation, processing and disposal as notified by the Authorities, failing of which, they shall be levied a fine. b) The waste generator shall deposit fees in advance, along with the application for sanction of the building plan. The charges notified by the Authority may be refundable after due deductions in case C&D waste management plan has been duly followed by waste generator. In case of any default, the whole amount shall be confiscated.

12.22 Weather Conditions

Weather forecast shall be obtained from the Indian Meteorological Department to have prior information on extreme weather conditions, and sudden and severe changes such

as strong winds, lightning, snow and heavy rain, etc. The work programme shall be planned accordingly to the changing weather condition.

12.23 Risk Management

A detailed hazard identification and risk assessment (HIRA) shall be carried out before starting the activity to identify hazards associated with the demolition process, assess such hazards, and take reasonably practicable steps to eliminate or control the risks arising from those hazards.

Hazard identification and risk assessment involves a five step risk assessment process as detailed below.

12.23.1 *Identifying the Hazards*

The first step in the risk management process is to identify the hazards associated with demolition work. The examples of demolition hazards include:

a) Unplanned structure collapse;
b) Fall of person from one level to another;
c) Falling objects;
d) The location of above ground and underground essential services, including the supply of gas, water, sewerage, telecommunications, electricity, chemicals, fuel and refrigerant in pipes or lines;
e) Exposure to hazardous chemicals – These may be present in demolished material or in the ground where demolition work is to be carried out (contaminated sites);
f) Hazardous noise from plant and explosives used in demolition work; and
g) The proximity of the building or structure being demolished to other buildings or structures.

12.23.2 *Assessing Risk*

The following sequence shall be followed while assessing the risk:

a) Identify the hazards associated with the proposed work;
b) Consider who might be harmed and how, including workers, site visitors, members of the public and anyone could be affected by the work;
c) Evaluate the risks and identify the precautions required by, for example, comparison with good practice and categorization of risk level (likelihood and severity);
d) Record the findings and implement the control measures for the residual risks; and
e) Review the risk assessment and update if necessary. All the control measures to be practised as per the risk assessment should be communicated to workmen involved in the activities

12.23.3 *Hierarchy of Risk Control*

While identifying the risk control adopt the hierarchy of risk control as per good practice [7(70)]. Examples of the risk controls as per the hierarchy is given in Table 6 below:

Table 6 Examples of the Risk Controls as per the Hierarchy
(*Clause* 12.23.3)

Sl No.	Hierarchy	Risk Control
(1)	(2)	(3)
i)	Elimination	Always aim to eliminate the hazards, utilizing the most effective control measures if this is not reasonably practicable, the risk shall be minimized by adopting the other methods as follows.
ii)	Substitution	Using a mechanical demolition method by selecting appropriate machinery like demolition hammer, balling machine or hydraulic pusher arm which is suitable and safer than a manual method.
iii)	Engineering control	Use concrete barriers to separate pedestrians and powered mobile plant to reduce the risk of collision. Fitting an open cab excavator with a falling objects protective structure to minimise the risk of being struck by a falling object. Go for implosion in case of carrying out demolition work in urban area.
iv)	Administrative control	Take so far as is reasonably practicable control measures like installing warning signs and establish an exclusion zone around the demolition work.
v)	Personal protective equipment	It shall be ensured that the workers are provided with adequate PPE and are wearing the same appropriately while they are involved in demolition activity. **Mandatory Personal Protective Equipment** Head protection — Safety helmet as per accepted standard [7(46)] Reflective vest — Reflective jacket as per accepted standard [7(71)] Foot protection — Safety shoes as per accepted standard [7(72)] **Activity Specific Personal Protective Equipment** a) Eye and face protection b) Respiratory protection c) Hearing protection d) Fall arresting equipment including full body harness and fall arrestors

12.24 Competencies and Training

12.24.1 All demolition and structural alteration activities should be carefully planned and carried out by contractor having previous experience and competency. Clients have a

key role and should ensure that all contractors, designers and other team members have either the competence to carry out the work themselves or have engaged the services of an individual or organization with these competencies.

12.24.2 Management of the contracting company should ensure that the necessary levels of competency exist with their work. Competency of their employees in the capability of managers, supervisors and workmen engaged for demolition are maintained at the level of experience have received suitable training from industry recognized training institutions.

12.24.3 Training facilitated to the persons involved in demolition activity shall cover the below topics:

a) Asbestos, lead and silica awareness and removal;
b) Oxygen/fuel cutting;
c) Scaffolding;
d) Working at height;
e) Material handling;
f) Demolition supervisor course;
g) Abrasive grinding;
h) Powered industrial truck operations;
j) Blasting operations; and
k) Personal protective equipment.

12.25 Permit to Work Procedure

The contractor shall issue a permit to work to any employee, likely to be exposed to hazardous work processes or hazardous working environment to secure the safety and health of the employee. Such work and workplace environment that may require permit to work, shall ensure:

a) Trained and competent workmen;
b) Floors free from danger of overload;
c) Protection to pedestrian;
d) Availability of sufficient fire extinguishers;
e) Availability of first-aid kit; and
f) Electrical equipment with test certificates and proper earth connections.

12.26 Emergency Arrangements

Emergency arrangements should be put in place before demolition activity. The following shall be provided, as appropriate:

a) Artificial resuscitator;
b) Stretchers;
c) Emergency lights and torch lights;
d) Rescue and resuscitation equipment;
e) Measures for raising the alarm and rescue;
f) Measures for safeguarding the rescuers;
g) Fire extinguishers;
h) First aid kit;
j) Public emergency services; and

k) Effective communication arrangement.

12.27 Controlling Asbestos Hazards

Presence of asbestos impregnated material in the demolishing structures shall be hazardous and harmful to health because the airborne asbestos fibres when inhaled cause serious health issue.

Airborne levels of asbestos are never to exceed legal worker exposure limits. There is really no 'safe' level of asbestos exposure for any type of asbestos fibres. Asbestos exposures, as short in duration as a few days have caused mesothelioma in humans. Every occupational exposure to asbestos can cause injury or asbestos-related disease.

a) Where there is exposure, employers are required to further protect workers by establishing regulated areas, controlling certain work practices and instituting engineering controls to reduce the airborne levels;

b) The employer is required to ensure exposure is reduced by using administrative controls and provide for the wearing of personal protective equipment; and

c) Medical monitoring of workers is also required when legal limits and exposure times are exceeded.

12.28 Controlling Silica Exposure

To control exposure to silica dust and fibres emitted out of demolition activity, avoid dry sweeping and the use of compressed air on concrete. Both these activities can stir up large amounts of dust. Use a vacuum with high efficiency filters when possible. When these activities cannot be avoided, respirators must be worn.

Best practices to help protect employees against exposures to silica include:

a) Replace crystalline silica materials with safer substitutes, whenever possible;

b) Provide engineering or administrative controls, where feasible, such as local exhaust ventilation and blasting cabinets. Where necessary to reduce exposures below the permissible exposure limit (PEL), use protective equipment or other protective measures;

c) Use all available work practices to control dust exposures, such as water sprays; and

d) Wear only a N95 certified respirator, if respirator protection is required. Do not alter the respirator. Do not wear a tight-fitting respirator with a beard or moustache that prevents a good seal between the respirator and the face.

12.29 Safety Signages

All demolition sites should display safety signages at appropriate locations. The signages should be visible from a minimum distance of 6 m. A list of suggested signages is attached in the Annex G.

12.30 List of Demolition Methodologies *see* Annex E.

12.31 General Checklist *see* Annex F.

SECTION 5 REPAIRS, RETROFITTING AND STRENGTHENING OF BUILDINGS

13 REPAIRS AND MAINTENANCE MANAGEMENT

13.1 General Principles and Concepts

13.1.1 *Non-Structural/Architectural Repairs*

13.1.1.1 The buildings affected by earthquake may suffer both non-structural and structural damages. Non-structural repairs may cover the damages to civil and electrical 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 connection details of architectural components to the main structural components to ensure their stability.

13.1.1.2 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 chimneys, 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.

13.1.2 *Structural Repairs/Restoration*

13.1.2.1 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 strength of 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.

13.1.2.2 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) If the crack width is small (for example, less than 10 mm), the restoration shall include the removal of portions of cracked masonry walls and piers and rebuilding them in richer mortar. Use of non-shrinking mortar or epoxy grouting will be preferable.

b) If the cracks are relatively wide (for example, more than 10 mm), 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) of appropriate fluidity, 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 fine 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.

NOTE — In mortar for masonry or plaster, fibres may be used.

13.1.3 Maintenance management of building is the art of preserving over a long period what has been constructed. Whereas construction stage lasts for a short period, 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. The maintenance management of buildings shall be done in accordance with Part 12 'Asset and Facility Management' of the Code.

14 PREVENTION OF CRACKS

14.1 Cracks in buildings are of common occurrence. A building 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.

14.2 Cracks could be broadly classified as structural or 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 a long 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.

14.3 For complete details on causes and prevention of non-structural cracks, reference shall be made to good practice [7(73)].

15 ~~REPAIRS AND~~ SEISMIC STRENGTHENING AND RETROFITTING OF BUILDINGS

The provisions of this clause will be suitably updated with the revised IS 13935, *Seismic Evaluation, Repair, and Strengthening of Masonry Buildings – Buildings – Doc: CED 39(26742)WC*.

15.1 General Principles and Concepts

15.1.1 *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, reinforcement 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.

15.1.2 *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 **15.1.3**.

15.1.3 *Strengthening or Retrofitting Versus Reconstruction*

15.1.3.1 Replacement of damaged buildings or existing unsafe buildings by reconstruction is, generally, avoided due to a number of reasons, the main 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.~~ The decision to undertake repair and seismic strengthening shall be made by the owner. 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.

15.1.3.2 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 IS codes.

15.2 For detailed guidelines for repairs and seismic strengthening of masonry buildings, reference shall be made to good practice [7(74)].

15.3 For detailed guidelines for improving earthquake resistance of low strength masonry buildings, reference shall be made to good practice [7(75)].

15.4 For detailed guidelines for improving earthquake resistance of earthen buildings, reference shall be made to good practice [7(76)].

15.5 For detailed guidelines for seismic evaluation and strengthening of existing reinforced concrete buildings, reference shall be made to good practice [7(77)].

SECTION 6 HABITAT AND WELFARE REQUIREMENTS FOR WORKERS

16 HABITAT AND OTHER WELFARE REQUIREMENTS FOR CONSTRUCTION WORKERS

16.1 The following aspects relating to habitat and other welfare requirements for construction workers at site shall be met with, in accordance with **16.2 to 16.16**:

a) Habitat site selection criteria;
b) Area requirements for the various facilities of the habitat;
c) Design of the habitat including the construction materials;
d) Specifications of living area, height of the rooms, windows and doors, ventilation;
e) Specification and requirements for kitchen and other sanitary facilities, such as toilets, bathrooms, etc;
f) Fire and safety requirements;
g) First aid and medical requirements;
h) Creches;
j) Habitat operation and maintenance;
k) Security;
m) Recreational facilities;
n) Waste management;
o) Habitat inspection and monitoring; and
p) Other facilities.

The project authorities should, depending on size of the project, number of workers employed, location of the project, etc, provide these facilities for the workers. They should also decide the nature of facilities that should be provided at the workplace within working hours.

16.2 Habitat Site Selection Criteria

16.2.1 The criteria given in **16.2.1.1** to **16.2.1.5** shall be met while selecting habitat site for construction workers.

16.2.1.1 Workers habitat shall be located away from overhead electrical lines. If due to non-availability of space, the habitat need to be located in the proximity of electrical line, minimum clearances as given in Part 3 ‘Development Control Rules and General Building Requirements’ of the Code shall be provided.

16.2.1.2 Workers’ habitat shall be located sufficiently away from areas like sewage channels, effluent treatment plants, garbage dumping yards, etc.

16.2.1.3 The site selected shall be such that it does not get flooded during monsoon and drainage available around the site for run-off water.

16.2.1.4 The site shall be separated from the construction site/public area by physical barrier such as fences.

16.2.1.5 Appropriate provisions shall be made for access to the site; and depending upon the location thereof, transportation of workers from their habitat to work locations.

16.3 Minimum Area Requirements

The area requirements as given in Table 7 shall be adopted in a construction workers' habitat.

For female workers and if workers' accommodation is provided for families of workers, separate sanitation facility for women with adequate privacy shall be provided as per Table 7.

Table 7 Area Requirements in Construction Workers' Habitat
(*Clause* 16.3)

Sl No.	Description	Quantity
(1)	(2)	(3)
i)	Minimum floor area per person	3.6 m^2
ii)	Maximum number of persons per room	10
iii)	Minimum height of the room	2.7 m, if two tier beds are provided 3 m
iv)	Minimum area of kitchen per person	0.60 m^2
v)	Number of lavatories, *Min*	1 per 10 person
vi)	Number of bathrooms, *Min*	1 unit per 15 person
vii)	Number of urinals, *Min*	1 per 25 person

16.4 Minimum Facilities to be Provided in Rooms

Following minimum facilities shall be provided in rooms of construction workers:

a) Adequate natural light during the day time and adequate artificial light;
b) Adequate ventilation to ensure sufficient movement of air in all conditions of weather and climate;
c) Lockable doors and windows, provided with mosquito screens where conditions warrant;
d) A separate bed for each worker;
e) Adequate furniture for each worker to secure his or her personal belongings, such as, a ventilated clothes locker which can be locked by the occupant to ensure privacy;
f) Separate storage for work boots and other personal protection equipment to be provided depending on conditions;
g) As far as practicable, sleeping rooms be so arranged that shifts are separated and that no workers working during the day share a room with workers on night shifts;
h) Beds not to be arranged in tiers of more than two.

16.5 Design and Construction of the Habitat

Design and construction of the workers' habitat meeting the requirements given in **16.2** to **16.4** shall be structurally sound and may be constructed at site or erected as prefabricated single/two storied accommodation.

16.6 Sanitary Facilities

Following sanitary facilities shall be provided at habitat for construction workers at site:

a) Every lavatory shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings.
b) Where both male and female building workers are employed, separate sanitary facilities shall be provided for female workers. There shall be displayed outside each block of lavatories or urinals a notice containing therein 'FOR MEN ONLY' or 'FOR WOMEN ONLY', as the case may be, written in the language understood by the majority of such workers. Such notice shall also bear the figure of a man or of a woman, as the case may be.
c) Every lavatory or urinal shall be conveniently situated and accessible to building workers at all times.
d) Every lavatory or urinal and washing facilities shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times.
e) Every lavatory or urinal other than those connected with a flush sewage system shall comply with the requirements of the public health authorities.
f) Water seal lavatories may be provided on the basis of community toilets or shared toilets as per the recommendation given in good practice [7(78)].
g) Water shall be provided by means of a tap or otherwise so as to be conveniently accessible in or near every lavatory or urinal.
h) The walls, ceilings and partitions of every lavatory or urinal shall be white-washed or colour-washed once in every period of six months.
i) Waste water from wash areas, bathrooms and toilets shall be drained in septic tanks/soak pits and suitably disposed in municipal sewerage systems. For very large habitat, sewage treatment plant may be installed. No waste water shall be discharged to ground or other sources without proper treatment.
j) Septic tanks/soak pits shall be located at a minimum distance of 18 m from the wells. Location of septic tank shall meet the requirements of good practice [7(79)].

16.7 Drinking Water Requirements

16.7.1 Sufficient quantity of potable water shall be made available for drinking. Drinking water shall meet the requirements of the accepted standard [7(80)] and water quality shall be monitored regularly.

16.7.2 Drinking water outlet shall be so located such that the distance to travel to nearest outlet shall not be more than 30 m. Drinking water tanks should be legibly marked 'Drinking Water' in a language understood by a majority of the workers and shall be located at least 6 m away from washing place, urinal or lavatory.

16.7.3 Sampling and testing of drinking water for checking its conformity to meet the requirements of **16.7.1** should be carried out quarterly through accredited laboratory.

16.7.4 Storage tanks shall be cleaned as part of regular maintenance procedure to prevent growth of slime and collection of sediments.

16.8 First Aid and Medical Facilities

16.8.1 First aid centre shall be established in the habitat with the required medical facilities. Trained first aiders/male nurse/doctor shall be employed in the First Aid Centre

depending on the number of workers accommodated. Sufficient number of first-aid boxes shall be provided and maintained and the box shall be distinctly marked 'First-aid' and shall be equipped with specified articles.

16.8.2 An emergency vehicle shall be provided or an arrangement shall be made with an identified nearby hospital for providing ambulance for transportation of serious cases of accident or sickness of workers to the hospital promptly. Such vehicle should be maintained in good repair and should be equipped with standard facilities. The contact details, including phone numbers of such nearby hospitals shall be readily available to different managers/supervisors/first-aid facility in-charge. These phone numbers shall also be suitably displayed at site.

16.8.3 Details of all the first-aid/medical treatments shall be logged in the first aid register.

16.8.4 Lighting of 300 lux shall be maintained in the first aid centre.

16.8.5 Health check-up of all the workers shall be done at least once in six months by a registered medical practitioner.

16.8.6 The medical facilities shall meet the provisions of *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act,* 1996 and rules framed thereunder.

16.9 Cooking Area

Cooking shall not be permitted in the living area. Separate designated kitchen shall be provided meeting the minimum area requirements given in **16.3**. Canteen and cooking facilities should provide sufficient space for preparing food and eating, as well as conform to hygiene and safety requirements. When workers can individually cook their meals, they should be provided with a space separate from the sleeping areas. Facilities must be kept in a clean and sanitary condition.

16.10 Creches

In every place wherein more than fifty female building workers are ordinarily employed, there shall be provided and maintained, a suitable room or rooms for the use of children under the age of six years of such female workers. Such rooms shall,

a) Provide adequate accommodation;
b) Be adequately lighted and ventilated;
c) Be maintained in a clean and sanitary condition; and
d) Be under the charge of women trained in the care of children and infants.

16.11 Habitat Operation and Maintenance

16.11.1 A detailed plan shall be prepared for the operation and maintenance of the habitat facilities. The plan shall cover all aspects of the operation, preventive and routine maintenance.

16.11.2 Qualified and experienced in-house electrical/maintenance personnel shall be present and available. A supervisor shall be appointed to supervise hygiene in the habitat

facilities. Sufficient cleaners shall be employed to ensure that the buildings and sanitary facilities are always clean and hygienic.

16.11.3 Regular pest and insect control measures shall be taken up to avoid mosquito/pest breeding. This may be done through an approved agency.

16.11.4 Worker's transportation may be done with standard passenger vehicle/bus, where required.

16.12 Fire Prevention

16.12.1 Fire extinguishers shall be provided such that one should not have to travel more than 15 m distance to access a fire extinguisher.

16.12.2 Diesel generator shed and inflammable liquid storage areas shall be provided with foam type fire extinguishers and fire buckets.

16.12.3 Electrical fittings in the inflammable storage areas shall be flame proof.

16.12.4 'NO SMOKING' boards shall be displayed in gas cylinder and flammable liquid storage areas.

16.12.5 All the security and habitat maintenance personnel, habitat residents and site workers shall be trained on use of fire extinguishers.

16.13 Recreation

Internal and external recreational facilities may be made available depending on the number of workers to be accommodated. Reasonable access to telephone or other modes of communications, with any charges for the use of these services being reasonable in amount, shall be provided.

16.14 Security

16.14.1 Adequate number of security personnel shall be deployed. Specific security personnel shall be deployed at the main entry gate for restricting unauthorized entry and checking vehicle/material exit and entry.

16.14.2 Security staff shall receive adequate training on first aid, firefighting and emergency preparedness. Security staff shall have a good understanding about the importance of respecting workers' rights and the rights of the communities. Security staff shall have the emergency lights, torches and other accessories required to facilitate during emergency situations.

16.14.3 A minimum of 50 lux lighting shall be maintained in the roads, parking area, boundary wall and other general areas of the habitat.

16.15 Other Facilities

Other facilities like provisional stores with separate counters for vegetables, etc, may also be provided in a construction workers habitat.

Facilities like induction/initiation room may be planned as the part of habitat for awareness, education and other related work site requirements.

16.16 Habitat Inspection

Periodical inspection of the habitat shall be carried out by an identified team preferably once in a month. The team shall record their findings on the inspection report form and team shall also review and follow-up implementation of the suggested measures. The above periodic inspection report of the habitat should be submitted to Project-in-Charge.

16.17 Notwithstanding the requirements given in **16.1** to **16.16**, all provisions given in relevant Act/Rules/Regulations as amended from time to time shall be followed; in this regard, reference shall also be made to the *Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act***,** 1996 and the rules/regulations framed thereunder.

ANNEX A
(*Clause* 10.2.1)

CHECK LIST FOR STACKING AND STORAGE OF MATERIALS

Sl 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, prefabri-cated brick panels and ferro-cement panels	✓						✓	✓		
	b) Channel units, cored 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, particle boards, fibre boards, blockboards and gypsum board			✓		✓	✓				✓
13.	Plastic and rubber flooring:										
	a) Sheets in rolls	✓						✓			✓
	b) Tiles	✓				✓	✓				✓
14.	Glass sheets		✓					✓			✓
15.	Glass bricks/blocks		✓			✓					✓
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
(Clause 12.21.1.1*)*

C&D WASTE MANAGEMENT PLAN

B-1 Please fill the table below and provide a layout plan demarcating all the plan attachments as requested.

General Details	
Company name:	Contact person (company): Address: Telephone no: Email:
Project name:	
Project site/ Location:	Name (person responsible for C&D Waste management plan): Contact Number:
Total area:	Project start date: / / (dd/mm/yy) Project end date: / / (dd/mm/yy)

Type of project: *(please tick as appropriate)*

New construction	
Renovation	
Addition/Expansion	
Deconstruction	
Demolition	

Project Specific Details	
1	Location and space for storage and segregation of C&D waste. (Attachment: Area demarcated on the layout plan of storage and segregation of C&D waste) Area provided for storage (m^2): …...
2	Please fill in details below of reuse and recycle plan of C&D waste in **format for proposed reuse and recycle of C&D waste.**

<table>
<tr><td>3</td><td>C&D waste collection and transportation:

a. Estimated user charges to be paid for transportation to the local Authority: ……

b. Proposed authorized point for disposal of the waste. (Please tick next to the corresponding option, and fill in details on name and address)

i. Local Authority designated site ……...

ii. C&D processing plant site ……...

iii. Other construction project site ……...

iv. Other (please specify) ……..

Name:

Address:</td></tr>
<tr><td>4</td><td>If C&D waste processing plant is proposed on-site, please demarcate the area of C&D waste processing plant on layout plan.
(Attachment: Area demarcated on the layout plan of location of C&D waste processing plant)</td></tr>
<tr><td>5</td><td>Please fill in details below on hazardous waste management
<table><tr><td>Estimated quantity of hazardous waste generated (in tonnes)</td><td></td></tr><tr><td>Method of transportation</td><td></td></tr><tr><td>Hazardous waste disposition centre</td><td>Name:
Address:</td></tr></table></td></tr>
<tr><td>6</td><td>Measures proposed for prevention of air (dust) and noise pollution.</td></tr>
<tr><td colspan="2">Please ensure to submit a copy of the layout plan with specific demarcations of the below:

i. Q1: Area for storage and segregation of C&D waste

ii. Q4: Location of C&D waste processing plant</td></tr>
</table>

B-2 Please also fill the table below indicating the proposed reuse/recycle methods and details.

Proposed reuse and recycle of C&D waste

Type of C&D waste	Estimated quantity (in tonnes)	Method of processing (On-site/off-site)	Recovery details of waste (percent of recovered waste)			In case of any on-site processing of waste, method of technology used	Proposed usage/course of action of recovered waste.
			Reuse	Processed	Recycled		

ANNEX C
(Clause 12.21.1.2 *and* Table 4*)*

C&D WASTE REUSE POTENTIAL

C-1 The reuse potential of the C&D waste is describe in Table 8.

Table 8 C&D Waste Reuse Potential
(Clause C-1)

Sl No.	Material	Process	End Use
(1)	(2)	(3)	(4)
i)	Demolition waste	Crushed and sorted	Recycled aggregate
ii)	Reinforced concrete	Crushed, sorted and steel bars removed Steel recycled	Recycled concrete aggregate For recycling
iii)	Clay bricks and roof tiles	Cleaned Crushed and sorted Pulverized	Reused for masonry Aggregate Mixed with lime to produce mortar
iv)	Calcium silicate bricks	Cleaned Crushed Pulverized	Reused for masonry Aggregate Recycled into new calcium silicate bricks
v)	Natural stone masonry	Cleaned Crushed	Reused for masonry Aggregate
vi)	Natural stone slabs	Cleaned Crushed	Flooring, cladding Aggregate
vii)	Ceramic tiles	Cleaned Crushed	Flooring, cladding Aggregate
viii)	Asphalt paving	Crushed and cold mixed Crushed and hot mixed	Road construction excluding wearing course
ix)	Mixed demolition waste (ABC, that is, asphalt, bricks, concrete)	Crushed	Fill material
x)	Steel	Cleaned Recycled	Reused steel components New steel components
xi)	Aluminium	Cleaned Recycled	Aluminium recycling streams
xii)	Timber beams, doors etc.	Cleaned	Reused as beams, doors, etc (if free of hazardous preservatives).

xiii)	Timber boards	Cleaned	Reused as shuttering and other products Feedback for engineered woods
xiv)	Plastics	Recycled	Plastic recycling streams
xv)	Gypsum plasterboard	Cleaned Crushed Recycled	Reuse as boards Soil conditioner New gypsum products
xvi)	Glass	Cleaned Crushed Recycled	Glass recycling streams

ANNEX D
(Clause 12.21.1.2 *and* Table 4*)*

RECORD OF C&D WASTE DETAILS

D-1 The record of C&D waste shall be detailed as in Table 9 and the record of reclaimed C&D waste brought for reuse shall be filled as in Table 10.

Table 9 Form for Record of C&D Waste Details

(*Clause* D-1)

Sl No.	Type of C&D Waste	Date of Generation of Waste *(dd/mm/yy)*	Total Quantity (tonnes)	Reused (in tonnes)		Recycled (in tonnes)			Disposed (in tonnes)	Course of Action for Reuse
				On site	Off site	For use on site	For use off site	Sent to recycling/ processing facility		
i)										
ii)										

Table 10 Reclaimed C&D Waste Materials
(*Clause* D-1)

Sl No.	Date C&D waste brought on-site (dd/mm/yy)	Quantity (in tonnes)	Name and address of site/location
i)			
ii)			

ANNEX E
(Clause 12.30*)*

LIST OF DEMOLITION METHODOLOGIES

E-1 The list of demolition methods are given below:

a) Manual demolition (sledge hammer)

b) Manual chipping (hand held chippers)

c) Tractor powered pneumatic breaker

d) Backhoe/Excavator attachments:
1) Hydraulic breaker
2) Hydraulic drum cutter
3) Hydraulic concrete crusher
4) Hydraulic steel scrap shear
5) Hydraulic drum cutter

e) Diamond cutting methods:
1) Floor sawing
2) Wall sawing
3) Wire sawing
4) Core drilling

f) Mechanical splitters and busters

g) Chemical bursting agents

h) Crane and ball method

j) Explosive demolition (implosion)

k) Thermic lancing

m) Robotic demolition

n) High impact hammer

p) Hydro-demolition using high pressure water jet.

q) Mechanical pull down method (mainly for steel structures)

r) Oxy acetylene cutting of steel structures

s) Specialised methods/equipment:
1) Drive breaker (For chimneys and cooling towers)
2) Multi head drive breaker (For concrete pavements)
3) High impact drive breaker (For pavements)

ANNEX F
(*Clause* 12.31)

GENERAL CHECKLIST

F-1 The general checklist as given below shall be maintained to ensure safety aspect in demolition.

Sl No.	**Item**	**Done**	**Not Done**	**Not Required**
(1)	(2)	(3)	(4)	(5)
i)	Prior to initiating demolition activities, has the demolition plan been approved by competent authority or by a registered professional engineer.			
ii)	Has an engineering survey by a registered professional engineer, of the structure been done.			
iii)	Have all electric, gas, water, steam, sewer, and other service lines been shut off, capped or otherwise controlled outside the building line before demolition is started.			
iv)	Have the proper personnel been notified to remove all hazardous material (lead, asbestos, etc).			
v)	Has contractor provided engineering drawings that indicate the location of all services lines and the means for their control.			
vi)	Has it been determined if any hazardous building materials, hazardous chemicals, gases, explosives, flammable materials, or dangerous substances have been used in any building construction, pipes, tanks, or other equipment on the property.			
vii)	When employees work within a structure to be demolished that has been damaged by fire, flood, explosion, or other cause, have the floors and walls been shored or braced.			
viii)	Has each story of exterior wall and floor construction been removed and dropped into the storage space below before commencing the removal of exterior walls and floors in the next story below.			
ix)	Have the entrances for employees to multi-storey structures being demolished been protected by sidewalk sheds, canopies, or both.			
x)	Is the designated means of access indicated on the demolition plan.			

Sl No.	Item	Done	Not Done	Not Required
(1)	(2)	(3)	(4)	(5)
xi)	Are continuing inspections by a competent person being made during demolition to detect hazards resulting from weakened or deteriorated floors, walls or loosened material.			
xii)	Are chute openings into which debris is dumped protected by a guardrail 100 cm above the floor or other surface on which personnel stand to dump the material.			
xiii)	Are signs warning of the hazard of falling materials posted at each side of the debris opening at each floor.			
xiv)	Are employees prohibited from working on the top of a wall during hazardous weather.			
xv)	Is there a Construction and Demolition waste management plan in place and competent authorities notified.			

F-2 The following shall also be maintained/used so as to ensure proper safety in the demolition activity and in the vicinity of the site.

Sl No.	Item	Done	Not Done	Not Required
(1)	(2)	(3)	(4)	(5)
	HEAVY EQUIPMENT/MOTOR VEHICLES			
i)	Is heavy equipment/motor vehicles inspecting each day prior to use and receive maintenance and servicing when needed.			
ii)	Are flagmen available where ever needed.			
iii)	Are state and local vehicle regulations observed.			
iv)	Are weight limits and load sizes observed.			
v)	As an administrative control, safety signages, caution boards shall be displayed at all the conspicuous locations of work location.			
vi)	Are only trained operators deployed for operating heavy equipment.			
vii)	Are only approved containers and portable tanks were used for storage and handling of flammable liquids.			
viii)	Are bulk containers of flammable liquids bonded and grounded during dispensing.			
ix)	Are containers of flammable gases and liquids clearly identified.			
x)	Are fire hazards checked during and after hours of inspection.			

Sl No.	Item	Done	Not Done	Not Required
(1)	(2)	(3)	(4)	(5)
xi)	Are flammable gases and liquids properly stored in fire rated cabinets.			
PREPLANNING AND PRECAUTIONS BEFORE STARTING DEMOLITION WORK				
i)	Prior to permitting employees to start demolition operations, an engineering survey of structures/buildings/equipment shall be made by our competent team, to determine structural integrity and the possibility of unplanned collapse of any portion of the structure/building/ equipment. All adjacent structures where employees may be exposed shall also be similarly checked. The employer shall have in writing, evidence that such a survey has been performed.			
ii)	Ensure that proper document/letter is available for demolition of a building/structure/equipment, etc, schematic sketches for the key plan and elevations showing the different buildings/structures/equipment etc, to be demolished, are to be prepared. Necessary documents are to be prepared.			
iii)	Adequacy and stability of parts to be demolished/retained, are to be ensured. A definite plan of procedure for the demolition work shall be prepared by contractor/consultants and finalized in consultation with the executing department/supervising department/supervising agency. A copy of the survey report and of the plans and/or methods of operations shall be maintained at the job site for the duration of the demolition operation.			
iv)	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.			

Sl No.	Item	Done	Not Done	Not Required
(1)	(2)	(3)	(4)	(5)
PLANNING				
i)	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 be 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.			
ii)	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.			
PROTECTION OF THE PUBLIC				
i)	Before any demolition work is started, every sidewalk or road adjacent to the work likely to be affected shall be closed or protected.			
ii)	Green cloth will be wrapped around the building to control dust, debris, blocks, bricks, glass or electrical sparks from falling near the demolition area.			
iii)	Deploy high-capacity dust suppression machine for the dust control			
iv)	Display of emergency evacuation plan, contact numbers and warning signage's			
BASIC TECHNICAL AND OTHER REQUIREMENTS				
i)	The equipment to be used for the work, including the size, type, position and coverage of proposed demolition high reach excavators, crane shall be indicated on a site plan.			
ii)	The provision of clear instructions for temporary bracing/ stays and propping etc.			
iii)	Ensure that the ground is compacted to any design specifications to enable plant to be			

Sl No.	Item	Done	Not Done	Not Required
(1)	(2)	(3)	(4)	(5)
	moved and used safely at the workplace.			
iv)	A supported scaffolding gantry should be installed to prevent inadvertent collapse during demolition.			
SAFE WORK PROCEDURE FOR DEMOLITION AND DISMANTLING				
i)	All works will be the subject of task and continuous risk assessments according to edifice standards.			
ii)	Ensuring the energies, Isolation and barricading of actual work site location.			
iii)	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, provision shall be made for at least two independent exits for escape of workmen during any emergency.			
iv)	All tools and tackles should have valid test certificate as per statutory norms for all the equipment engaged for demolition job.			
v)	Risk to health and adequate control measures to be taken in case of use of Hazardous substances for example, hydraulic oil, diesel, gases (oxygen/etc).			
vi)	Personal protective equipment (PPEs) to be used.			
vii)	Availability of movable hard barricading and soft barricading with warning signage's.			
viii)	Predefined pathway for vehicular and machinery movement with traffic marshals.			
ix)	Availability water supplyfor dust suppression and decontamination purpose.			
x)	Ensure daily tool box talk and work permit system.			
xi)	Follow the approved dismantling sequence.			
xii)	Ensure daily checklist of machineries on site.			
xiii)	Availability of material safety data sheets (MSDS) of chemicals near work area.			
xiv)	Ensure isolation of flammables from work area during hot work and monitoring of hazardous gases during hot work using multi gas detectors.			
xv)	Availability of portable fire fighting equipment and identification of nearby hydrant points.			

Sl No.	Item	Done	Not Done	Not Required
(1)	(2)	(3)	(4)	(5)
xvi)	Hard and soft barricading to avoid unauthorised entry continuous work monitoring.			
xvii)	Clear responsibility to be given: executing authority to be designated.			
xviii)	Technical content of the job should be taken care.			
xix)	Disposal of demolished debris and scrap as per instruction of the executing authority.			

NOTE — The above list is only indicative and can be modified based on different demolition processes.

ANNEX G
(*Clause* 12.29)

SAFETY SIGNAGES

G-1 The following signages shall be appropriately selected and placed conspicuously.


WARNING
Explosive materials.
Unauthorized persons keep out.


WARNING
FALL HAZARD


Warning
People working overhead


Fire assembly point


WARNING


CAUTION
HEAVY EQUIPMENT IN OPERATION

ANNEX H
(*Clause* 5.9)

GENERIC NAMES FOR BIM SOFTWARE CAPABILITY

H-1 A well-defined software strategy is essential for Construction sector organization undergoing digital transformation, ensuring that BIM solutions align with business objectives and industry needs. With hundreds of BIM tools available, selecting the right software requires careful consideration of factors such as interoperability with existing systems, cost-effectiveness, industry-specific applicability, and the availability of skilled professionals. A strategic approach helps organizations maximize efficiency, streamline workflows, and enhance collaboration, ultimately driving better project outcomes.

H-2 BIM software/s has several capabilities such as briefing, workflow, authoring, integration, collaboration, analysis, visualization, planning, costing etc. All the capabilities of BIM software/s are discussed below.

Briefing – Defining project scope, objectives, and requirements.
Workflow – Managing project processes and team coordination.
Surveying – Capturing site conditions using traditional methods.
Scanning – Using laser scanning or photogrammetry for as-built documentation.
Design – Creating architectural, structural, and MEP models.
Authoring – Developing detailed BIM models in discipline-specific software.
Integrating – Combining multiple models for coordination and interoperability.
Collaboration – Enabling multidisciplinary teamwork and data exchange.
Reviewing – Conducting design reviews and model audits.
Checking – Performing model validation and compliance checks.
Commenting – Annotating and providing feedback on BIM models.
Analysis – Conducting simulations (structural, energy, thermal, etc.).
Visualization/Rendering – Generating 3D visuals and presentations.
Planning – Creating construction schedules and logistics plans.
Costing – Estimating quantities and expenses using BIM data.
Tracking – Monitoring on-site progress against the BIM model.
Progress Reviewing – Comparing actual versus planned progress.
Viewing – Accessing models on-site for reference and validation.
Manufacturing – Producing prefabricated components from BIM data.
Ordering – Managing procurement and supply chain integration.
Analysis Planning – Evaluating operational performance for efficiency improvements.
Measuring – Capturing real-time building performance data.
Recording – Documenting maintenance activities and updates.
Validating – Ensuring as-built conditions match BIM data.
Publishing – Sharing finalized models for facility management and future use.

ANNEX J
(*Clause* 5.10)

BIM AND DIGITALIZATION ROLES

J-1 BIM and Digitalization roles are broadly classified into production, management and leadership roles. Client, General Contractor, Sub-Contractors, Consulting firms, Asset Operations and government agencies all require BIM team. The BIM roles required in each type of organisation varies. Broader set of BIM roles are discussed in this module. Skill and capacity building for each BIM roles at production, management and leadership level varies.

J-1.1 BIM Production and Specialist Roles

BIM Production roles focus on modelling, documentation, coordination and collaboration, quality control and delivery. BIM Modellers for Architectural, Landscape, Interior design, Civil, Structural, Mechanical, Electrical, Plumbing, Fire protection, Electrical Alarm System, Information Technology, Security and Audio-Visual. BIM Engineer for object / family / library creation.

BIM Specialist roles are for 4D BIM - Construction planning and monitoring, 5D BIM - for cost planning and monitoring, Immersive Experience, VDC simulations, Reality capture, Lean and Green, Geo-BIM, smart contracts, return on investment (ROI), Safety and Risk, Procurement and Logistics, Digital Twin and Building Automation.

J-1.2 BIM Co-ordination and Management Roles

BIM Co-ordination and Management roles focus on project planning, coordination and collaboration, implementation and planning, standards and guidelines, model management and quality control. BIM Coordinators for Design, Construction and Asset Management, trainings, partnerships and CDE, modular strategies. BIM Manager for information management in design, construction and Asset management.

J-1.3 BIM Advisory and Leadership Roles

BIM Advisory and leadership roles focus on strategy / roadmap development, standards and guidelines, implementation planning, training and support, coordination and collaboration, partnerships, Investments and ROI.

BIM Advisory is an expert role who understands market level digital transformation and deeply connected in BIM ecosystem. They can advise architecture, engineering and construction (AEC) sector organisations on organisational and business strategies, support in critical decision making in-terms of software, hardware, team building, partnerships, trainings and workflow strategies, support in activating BIM and digital departments within organizations and handhold during the transformation journey.

BIM Leadership is a senior role in architecture, engineering, construction and operations (AECO) sector organizations. They understand the pain-points and change management approach to support the BIM adoption. They have good understanding on project strategies which deep dives on understanding customer requirements and building the team that support the customer's expectation. BIM production and management roles

report to leadership role. They are responsible to get the BIM workflow aligned to procure organization's BIM certification.

ANNEX K
(*Clause* 5.11)

HARDWARE AND EQUIPMENT IN BIM IMPLEMENTATION

K-1 Hardware or Equipment are key for any construction sector organisation during their transformation journey. Hardware requirements needed for BIM, including high-performance workstations, mobile devices, experience / control centre, Jai-bot, laser scanner, drone, 360° camera, total station, VR and AR devices, Cyber dog, 3D printer and plotter.

K-1.1 Work-station, Laptop, Tablet and Mobile devices

Work station and Laptop processor, RAM, hard disk, Graphics card, browser, connectivity, operating system, compatibility, pricing, and data exchange formats. Basic understanding on brands available in market for easy sync with BIM ecosystem.

K-1.2 Experience Centre and Control Rooms

Enables projects of all sizes to be realised in an immersive, interactive and collaborative virtual environment. It provides 1:1 experience of the projects and its related data. The cutting edge VR devices allows team to work together rather than alone via a headset. BIM Experience Centre can be set up for enabling experience and coordination meetings.

K-1.3 BIM to Field, Reality Capture and Visualisation

BIM to field equipment like Jai-bot and total station for semi- automated overhead drilling for MEP works, reality capture device like laser scanner for progress monitoring and creation of accurate as-built models, and visualisation equipment like virtual reality for immersive experience of project, Augmented reality device for site trainings, site co-ordination, quality control and progress monitoring, Total station for BIM guided site survey and updating as-built models.

K-1.4 Reality Capture Device - Drone, 360 Camera and Cyber Dog

Drone usage for aerial mapping and construction management, 360-degree camera for reality capture and site progress monitoring, Cyber dog for scanning, quality control and site progress monitoring, Indoor scanner for scanning interior spaces in high details to enable visualisation, measurements, snag lists and reporting. Reality capture data can enable pre-site survey, enhanced site logistics, earth work, quantification, capture critical milestones, site document control, progress documentation, Quality assurance and control and to compare BIM models.

K-1.5 3D Printer, Plotter, Presenter, Holo-table, Wall and Room

3D Printer for automating the construction process by using large-scale 3D printers capable of creating entire buildings or structural components. Plotter for producing high-quality, large-format drawings, plans, and graphics. Holographic indoor presenter. Holo table / wall / room for immersive experience.

The Holo-Table is a 2 X 2m device that provides a bird’s eye view of realistic 3D data. The table is best for visualizing landscapes and tracking real- time developments. The

Holo-Wall creates a 2 X 3.5m screen which visualizes 3D information and acts as an interface between the real and virtual world. Holograms can extend out into the room up to 4m. The Holo-Room is a 4 X 5m fully immersive room, suitable for lifelike and life-size experiences and realistic simulations. All 3D filetypes can be displayed and interacted with.

ANNEX M
(*Clause* 5.12)

IMPACTS AND BENEFITS OF GENERATING AND USING BIM

M-1 Benefits of implementing BIM and digital techniques from an organizational perspective can be evaluated in economic terms across the following eight categories. The potential benefits can only be augmented overall by implementing the ramp-up in phases, which demands an extended development and change process. The business centres and service units benefit primarily from the acceleration of project execution and project quality improvements.

M-1.1 Time Savings

Time savings can be realized throughout each stage of the asset lifecycle, including service delivery (or business as usual). For example, use of a common data environment (CDE) enables easier ways of working and quicker information exchange.

M-1.2 Material Savings

Material savings can be achieved during the build, commission, operation, and end of life (maintenance, refurbishment, etc) stages of the asset lifecycle by reducing the volume of materials required (including reducing wasted materials).

M-1.3 Cost Savings

In the asset lifecycle where it is difficult to distinguish the component time and materials elements. The benefits framework may include cost savings from fewer changes, better clash detection, and improvements in facilities management and maintenance.

M-1.4 Health and Safety Improvement

Health and safety improvements can be observed during the build, commissioning, operation, and end of life stages of the asset lifecycle. For example, a 3D model provides the visual basis for improved staff briefing and training, with further potential provided through 4D-type simulations, (including construction and demolition activities), to optimize sequencing from a safety perspective.

M-1.5 Risk Reduction

The use of BIM Level 2 has the potential to improve the accuracy of information about a project or asset, and improve visibility about associated costs, delivery timeline, and risks. As a result of this increased certainty provided by BIM Level 2, there is a potential for a reduction in the variability of costs and time required for asset delivery and operation. This may result in the ability to reduce the contingency required against capital expenditure (CAPEX) and/or operating expenditure (OPEX), thus resulting in a reduction in costs associated with that contingency.

M-1.6 Improved Asset Utilization

The use of BIM Level 2 can improve the availability and productive use of an asset throughout its lifetime. Better space utilization planning, faster maintenance and

refurbishment through use of an asset information model, and faster BIM enabled response to incidents can improve asset availability or reduce downtime.

M-1.7 Improved Asset Quality

Improved visibility over the process of design and construction, which can enable improved quality of the asset for the end-user. For example, BIM's 3D and 4D visualization capabilities may result in better building layouts or enhanced occupant experiences, such as optimizing building orientation for increased sunlight.

M-1.8 Improved Reputation

BIM implementation can potentially improve the reputation of construction clients, asset owners, and the supply chains involved in asset delivery by improving the experience of those associated with asset delivery and service delivery. For example, in asset delivery, use of BIM Level 2 may result in better site layout and improved logistics. This could reduce (or avoid) negative impacts on residents, businesses and customers who reside near the construction site.

LIST OF STANDARDS

The following list records those standards which are acceptable as 'good practice' and 'accepted 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 for conformance with the requirements of the referred clauses in the Code.

In the following list, the number appearing in the first column within parenthesis indicates the number of the reference in this Part.

	IS No.	*Title*
(1)	7337 : 2020	Project management – Glossary of terms (*third revision*)
	10400 : 2013	Glossary of terms in inventory management (*second revision*)
	15198 : 2014	Glossary of terms in human resource development
(2)	16416 : 2016	Construction project management: Project formulation and appraisal – Guidelines
	14580(Part 1) : 2020	Project planning, monitoring and control Part 1 methodology (*first revision*)
(3)	14580 (Part 2) : 2006	Use of network analysis for project management – Part 2 Use of graphic technique
(4)	15883 (Part 6) : 2015	Guidelines for construction project management – Part 6 Scope management
(5)	15883 (Part 7) : 2021	Construction project management – Guidelines Part 7 Procurement Management
(6)	15883 (Part 2) : 2013	Guidelines for construction project management – Part 2 Time management
(7)	15883 (Part 3) : 2015	Guidelines for construction project management – Part 3 Cost management
(8)	15883 (Part 4) : 2015	Guidelines for construction project management – Part 4 Quality management
(9)	15883 (Part 8) : 2015	Guidelines for construction project management – Part 8 Risk management
(10)	15883 (Part 9) : 2018	Construction project management – Guidelines Part 9 Communication management
(11)	15883 (Part 10) : 2021	Construction project management – Guidelines Part 10 Human resource management
(12)	IS/ISO 45001 : 2018	Occupational health and safety management systems – Requirements with guidance for use *(second revision)*
(13)	15883 (Part 5) : 2013	Guidelines for construction project management – Part 5 Health and safety management
(14)	IS 15883 (Part 1) : 2009	Construction Project Management – Guidelines Part 1 General
(15)	15883 (Part 11) : 2021	Construction project management – Guidelines Part 11 Sustainability management
(16)	15883 (Part 12) : 2016	Construction Project Management - Guidelines Part 12 Integration Management

(17)	IS 17893 : 2023	Work permit system – Code of Practice
(18)	a) *Foundations*	
	1080 : 1985	Code of practice for design and construction of shallow foundations on soils (other than raft, ring and shell) (*second revision*)
	1904 : 2021	General requirements for design and construction of foundations in soils — Code of practice (*fourth revision*)
	2911	Code of practice for design and construction of pile foundations
	(Part 1/Sec 1): 2010	Concrete piles, Section 1 Driven cast, *in-situ* concrete piles (*second revision*)
	(Part 1/Sec 2): 2010	Concrete piles, Section 2 Board cast, *in-situ* concrete piles (*second revision*)
	(Part 1/Sec 3): 2010	Concrete piles, Section 3 Precast driven concrete piles (*second revision*)
	(Part 1/Sec 4): 2010	Concrete piles, Section 4 Precast concrete piles in prebored holes (*first revision*)
	(Part 2) : 2021	Timber piles (*second revision*)
	(Part 3) : 2021	Under-reamed piles (*second revision*)
	(Part 4) : 2013	Load test on piles (*second revision*)
	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*)
	9456 : 1980	Code of practice for design and construction of conical and hyperbolic paraboidal types of shell foundations
	9556 : 1980	Code of practice for design and construction of diaphragm walls
	12070 : 1987	Code of practice for design and construction of shallow foundations on rock
	13094 : 2021	Selection of ground improvement techniques for weak soils - Guidelines (*first revision*)
	14593 : 1998	Design and construction of bored cast-in-situ piles founded on rocks - Guidelines
	15284	Design and construction for ground improvement:
	(Part 1) : 2003	Stone columns
	(Part 2) : 2004	Preconsolidation using vertical drains

b) *Masonry*

1597	Code of practice for construction of stone masonry
(Part 1) : 1992	Part 1 Rubble stone masonry (first revision)
(Part 2) : 1992	Part 2 Ashlar masonry (first revision)
2110 : 1980	Code of practice for in-situ construction of walls in buildings with soil-cement (first revision)
2212 : 1991	Code of practice for brickwork (first revision)
2250 : 1981	Code of practice for preparation and use of masonry mortars (first revision)
2572 : 2005	Code of practice for construction of hollow and solid concrete block masonry (first revision)
3630 : 1992	Code of practice for construction of non-load bearing gypsum block partitions (first revision)
4407 : 1967	Code of practice for reed walling
4441 : 1980	Code of practice for use of silicate type chemical resistant mortars (first revision)
4442 : 1980	Code of practice for use of sulphur type chemical resistant mortars (first revision)
4443 : 1980	Code of practice for use of resin type chemical resistant mortars (first revision)
6041 : 1985	Code of practice for construction of autoclaved cellular concrete block masonry (first revision)
6042 : 1969	Code of practice for construction of light weight concrete block masonry (first revision)

c) *Timber and Bamboo*

1634 : 1992	Code of practice for design and constructions of wood stair for houses (*second revision*)
2366 : 1983	Code of practice for nail-jointed timber construction (*first revision*)
3670 : 1989	Code of practice for construction of timber floors (*first revision*)
4913 : 1968	Code of practice for selection, installation and maintenance of timber doors and windows
4983 : 1968	Code of practice for design and construction of nail laminated timber beams
5390 : 1984	Code of practice for construction of timber ceilings (*first revision*)
11096 : 1984	Code of practice for design and construction of bolt-jointed timber construction
12506 : 1988	Code of practice for improved thatching of roof with wrought and fire retardant treatment

d) *Concrete*

456 :2000	Code of practice for plain and reinforced concrete (*fourth revision*)

457 : 1957	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures
1343:2012	Prestressed Concrete - Code Of Practice *(second revision*)
2502 : 1963	Code of practice for bending and fixing of bars for concrete reinforcement
2541 : 1991	Code of practice for preparation and use of lime concrete (*second revision*)
3370	Concrete structures for retaining aqueous liquids - Code of practice
(Part 1) : 2021	General Requirements (*second revision*)
(Part 2) : 2021	Plain and reinforced concrete (*second revision*)
(Part 3) : 2021	Prestressed concrete (*first revision*)
3558 : 1983	Code of practice for use of immersion vibrators for consolidating concrete (*first revision*)
4926 : 2003	Code of practice for ready-mixed concrete (*second revision*)
5817 : 1992	Code of practice for preparation and use of lime pozzolana mixture concrete in buildings and roads (*first revision*)
7246 : 1974	Recommendations for use of table vibrators for consolidating concrete
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
10262 : 2019	Concrete mix proportioning — Guidelines *(second revision)*
10359 : 1982	Code of practice for manufacture and use of lime pozzolana concrete blocks for paving
14687 : 1999	Guidelines for falsework for concrete structures

e) *Steel*

800 : 2007	Code of practice for general construction in steel - (*third revision*)
801 : 1975	Code of practice for use of cold formed light gauge steel structural members in general building construction (*first revision*)
805 : 1968	Code of practice for use of steel in gravity water tanks
806 : 1968	Code of practice for use of steel tubes in general building construction (*first revision*)
4000 : 1992	Code of practice for high strength bolts in steel structures (*first revision*)
4180 : 1967	Code of practice for corrosion protection of light gauge steel sections used in building
6533	Code of practice for design and construction of steel chimneys
(Part 1) : 1989	Mechanical aspects (*first revision*)
(Part 2) : 1989	Structural aspects (*first revision*)
8629(Parts 1 to 3): 1977	Code of practice for protection of iron and steel structures from atmospheric corrosion

9077 : 1979	Code of practice of corrosion protection of steel reinforcement in RB and RCC construction
9172 : 1979	Recommended design practice for corrosion prevention of steel structures

f) *Flooring and Roofing*

658 : 1982	Code of practice for magnesium oxychloride composition floors (*second revision*)
1196 : 2023	Laying bitumen mastic flooring — Code of practice (*third revision*)
1197 : 1970	Code of practice for laying of rubber floors (*first revision*)
1198 : 1982	Code of practice for laying, fixing and maintenance of linoleum floor (*first revision*)
1443 : 2018	Laying and finishing of cement concrete tiles — Code of practice (*second revision*)
2118 : 1980	Code of practice for construction of jack-arch type of building floor or roof (*first revision*)
2119 : 1980	Code of practice for construction of brick-cum-concrete composite (Madras terrace) floor or roof (*first revision*)
2204 : 1962	Code of practice for construction of reinforced concrete shell roof
2571 : 1970	Code of practice for laying in-situ cement concrete flooring (*first revision*)
2700 : 1987	Code of practice for roofing with wooden shingles (*first revision*)
2792 : 1964	Code of practice for design and construction of stone slab over joist floor
2858 : 1984	Code of practice for roofing with Mangalore tiles (*first revision*)
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*)
3670 : 1989	Code of practice for construction of timber floors (*first revision*)
5119	Code of practice for laying and fixing of sloped roof coverings
(Part 1) : 1968	Slating
5318 : 1969	Code of practice for laying of flexible PVC sheet and tile flooring
5389 : 1969	Code of practice for laying of hard wood parquet and wood block floors
5390 : 1984	Code of practice for construction of timber ceilings (*first revision*)
5766 : 1970	Code of practice for laying burnt clay brick flooring
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
6332 : 1984	Code of practice for construction of floors and roofs using precast doubly-curved shell units (*first revision*)
9472 : 1980	Code of practice for laying mosaic parquet flooring
10297 : 1982	Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units
10440 : 1983	Code of practice for construction of reinforced brick and RBC floors and roofs
10505 : 1983	Code of practice for construction of floors and roofs using precast concrete waffle units

g) *Finishes*

1346 : 1991	Code of practice for waterproofing of roofs with bitumen felts (*third revision*)
1414 : 1989	Code of practice for fixing wall coverings
1477	Code of practice for painting of ferrous metals in buildings
(Part 1) : 1971	Pretreatment (*first revision*)
(Part 2) : 1971	Painting (*first revision*)
1609 : 1991	Code of practice for laying damp-proofing treatment using bitumen felts (*second revision*)
1661 : 1972	Code of practice for application of cement and cement lime plaster finishes (*first revision*)
2114 : 2018	Laying in - Situ terrazzo floor finish — Code of practice (*second revision*)
2115 : 1980	Code of practice for flat-roof finish: Mud PHUSKA (*second revision*)
2338	Code of practice for finishing of wood and wood based materials
(Part 1) : 1967	Operations and workmanship
(Part 2) : 1967	Schedules
2394 : 1984	Code of practice for application of lime plaster finish (*first revision*)
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*)
2402 : 1963	Code of practice for external rendered finishes
2441 : 1984	Code of practice for fixing ceiling covering (*first revision*)
2524	Code of practice for painting of non-ferrous metals in buildings
(Part 1) : 1968	Part 1 Pre-treatment
(Part 2) : 1968	Part 2 Painting
3036 : 2022	Laying lime concrete for a waterproofed roof finish — Code of practice (*third revision*)
3067 : 1988	Code of practice for general design details and preparatory work for damp-proofing and waterproofing of buildings (*first revision*)
3140 : 1965	Code of practice for painting asbestos cement building products

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*)
4365 : 1967	Code of practice for application of bitumen mastic for waterproofing of roofs
4597 : 1968	Code of practice for finishing of wood and wood based products with nitrocellulose and cold catalysed materials
4631 : 1986	Code of practice for laying of epoxy resin floor toppings (*first revision*)
5491 : 1969	Code of practice for laying *in-situ* granolithic concrete floor topping
6278 : 1971	Code of practice for white-washing and colour washing
6494 : 1988	Code of practice for waterproofing of underground water reservoirs and swimming pools (*first revision*)
7198 : 1974	Code of practice for damp-proofing using bitumen mastic
7290 : 1979	Recommendations for use of polyethylene film for waterproofing of roofs (*first revision*)
9918 : 1981	Code of practice for in-situ waterproofing and damp-proofing treatments with glass fibre tissue reinforced bitumen
10439 : 1983	Code of practice for patent glazing
16135 : 2014	Code of practice for dry lining and partitioning using gypsum plasterboards
16231	Use of glass in buildings — Code of practice
(Part 1) : 2019	General methodology for selection *(first revision)*
(Part 2) : 2019	Energy and light *(first revision)*
(Part 3) : 2019	Fire and loading *(first revision)*
(Part 4) : 2019	Safety related to human impact *(first revision)*

h) *Piping*

783 : 1985	Code of practice for laying of concrete pipes (*first revision*)
3114:1994	Code of practice for laying of cast iron pipes (*second revision*)
4127:2023	Laying of glazed stoneware pipes — Code of practice (*second revision*)
5329 : 1983	Code of practice for sanitary pipe work above ground for buildings (*first revision*)
5822 : 1994	Code of practice for laying of welded steel pipes for water supply (*second revision*)
6530 : 1972	Code of practice for laying of asbestos cement pressure pipes
7634	Code of practice for plastics pipe work for portable water supplies
(Part 1) : 1975	Part 1 Choice of materials and general recommendations
(Part 2) : 2012	Part 2 Laying and jointing polyethylene (PE) pipes (*first revision*)

(Part 3) : 2003	Part 3 Laying and jointing of unplasticized PVC pipes
13916 : 1994	Code of practice for installation of glass fibre reinforced plastic piping system

j) *Measurements*

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 (*third revision*)
(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 dismantling (*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
3861 : 2002	Method of measurement of plinth, carpet and rentable areas of buildings (*second revision*)

k) *Others*

1081 : 1960	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
1649 : 1962	Code of practice for design and construction of flues and chimneys for domestic heating appliances
1946 : 1961	Code of practice for use of fixing devices in walls, ceilings and floors of solid construction
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*)

	2527 : 1984	Code of practice for fixing rain-water gutters and down pipes for roof drainage (*first revision*)
	3414 : 1968	Code of practice for design and installation of joints in buildings
	3548 : 1988	Code of practice for glazing in buildings (*first revision*)
	3558 : 1983	Code of practice for use of immersion vibrators for consolidating concrete (*first revision*)
	3935 : 1966	Code of practice for composite construction
	4326 : 2013	Code of practice for earthquake resistant design and construction of buildings (*third revision*)
	4913 : 1968	Code of practice for selection, installation and maintenance of timber doors and windows
	6313 (Part 1) : 1981	Code of practice for anti-termite measures in buildings Constructional measures (*first revision*)
	(Part 2) : 2022	Pre-constructional chemical treatment measures (*fourth revision*)
	(Part 3) : 2022	Treatment for existing buildings (*fourth revision*)
	6924 : 1973	Code of practice for the construction of refuse chutes in multistoreyed buildings
	7246 : 1974	Recommendation for use of table vibrators for consolidating concrete
	8147 : 1976	Code of practice for use of aluminium alloys in structures
	15345 : 2003	Installation of frameless door and window shutters — Code of practice
	15916 : 2020	Building design and erection using prefabricated concrete - Code of practice (*first revision*)
	15917 : 2020	Building design and erection using mixed / composite construction - Code of practice (*first revision*)
	17401 : 2021	Design and construction of buildings using glass fibre reinforced gypsum panels — Code of practice
(19)	IS 14243 (Part 1) : 1995	Selection and development of site for building in hill areas – Guidelines Part 1 Microzonation of urban centres
(20)	IS 14243 (Part 2) : 1995	Selection and development of site for building in hill areas – Guidelines Part 2 Selection and development
(21)	IS 14458 (Part 1) : 1998	Retaining wall for hill area – Guidelines Part 1 selection of type of wall
(22)	IS 14458 (Part 2) : 1997	Retaining wall for hill area – Guidelines Part 2 design of retaining/breast walls
(23)	IS 14458 (Part 3) : 1998	Retaining wall for hill area – Guidelines Part 3 Construction of dry stone walls
(24)	IS 14458 (Part 4) : 2018	Retaining wall for hill areas – Guidelines Part 4 Construction of Banded Dry Stone Masonry Walls
(25)	IS 14458 (Part 5) : 2018	Retaining wall for hill areas – Guidelines Part 5 construction of cement stone masonry walls
(26)	IS 14458 (Part 6) : 2020	Retaining wall for hill area – Guidelines Part 6 Construction of Gabion Walls
	IS 14458 (Part 7) : 2022	Retaining wall for hill area – Guidelines Part 7 Construction of peripheral reinforced gabion walls
(27)	IS 18736 : 2024	Micropiles for slope stabilization for mitigation of landslides – Guidelines

(28)	IS 14804 : 2000	Siting, design and selection of materials for residential buildings in hilly areas – Guidelines
(29)	IS 14961 : 2024	Surface water management in hilly areas (including rainwater harvesting) – Guidelines (*first revision*)
(30)	IS 3764 : 1992	Excavation work– Code of safety *(first revision)*
(31)	IS 3696 (Part 1) : 1987	Safety code for scaffolds and ladders Part 1 Scaffolds
	IS 3696 (Part 2) : 1991	Scaffolds and ladders – Code of safety Part 2 Ladders (*first revision*)
(32)	IS 2911	Code of practice for design and construction of pile foundations
	(Part 1/Sec 1): 2010	Concrete piles, Section 1 Driven cast, *in-situ* concrete piles (*second revision*)
	(Part 1/Sec 2): 2010	Concrete piles, Section 2 Board cast, *in-situ* concrete piles (*second revision*)
	(Part 1/Sec 3): 2010	Concrete piles, Section 3 Precast driven concrete piles (*second revision*)
	(Part 1/Sec 4): 2010	Concrete piles, Section 4 Precast concrete piles in prebored holes (*first revision*)
	(Part 2) : 2021	Timber piles (second revision)
	(Part 3) : 2021	Under-reamed piles (*second revision*)
	(Part 4) : 2013	Load test on piles (*second revision*)
(33)	IS 2950 (Part 1) : 1981	Code of practice for design and construction of raft foundations Part 1 Design *(second revision)*
(34)	2750 : 1964	Specification for steel scaffoldings
	14687 :1999	Guidelines for falsework for concrete structures
	3696(Part 1) :1987	Safety code for scaffolds and ladders: Scaffolds
	4014	Code of practice for steel tubular scaffolding
	(Part 1) :1967	Definitions and materials
	(Part 2) : 2013	Safety regulations for scaffolding (*first revision*)
(35)	6521	Code of practice for design of tower cranes:
	(Part 1) : 1972	Static and rail mounted
(36)	13558	Cranes - Control layout and characteristics – Part 3
	(Part 3) : 2018	Tower cranes (*first revision*)
(37)	14687 : 1999	Guidelines for falsework for concrete structures
(38)	3764 : 1992	Safety code for excavation work (*first revision*)
(39)	13416	Recommendations for preventive measure against hazards at workplaces:
	(Part 5) : 1994	Fire protection
(40)	11769	Guidelines for safe use of products containing asbestos:
	(Part 1) : 1987	Asbestos cement products
(41)	15683 : 2018	Portable fire extinguishers — Performance and construction — Specification (*first revision*)
	16018 : 2012	Specification for wheeled fire extinguishers — Performance and construction
(42)	2190 : 2010	Code of practice for selection, installation and maintenance of first-aid fire extinguishers (*fourth revision*)

(43)	8758 : 2013	Code of practice for fire precautionary measures in construction of temporary structures and pandals (*second revision*)
(44)	10439 : 1983	Code of practice patent glazing
	14687 : 1999	Guidelines for falsework for concrete structures
(45)	4138 : 1977	Safety code for working in compressed air (*first revision*)
(46)	2925 : 1984	Specification for industrial safety helmets (*second revision*)
(47)	2750 : 1964	Specification for steel scaffoldings
(48)	3696	Safety code for scaffolds and ladders:
	(Part 1) : 1987	Scaffolds
	4014	Code of practice for steel tubular scaffolding:
	(Part 2) : 2013	Safety provisions for scaffolding
(49)	3696	Safety code for scaffolds and ladders:
	(Part 2) : 1991	Ladders
(50)	4912 : 2024	Temporary protection of floor and wall openings, open-side floors, staircases and guardrail systems — Safety requirements (*second revision*)
(51)	11461 : 2024	Compressor safety — Code of practice (*first revision*)
(52)	IS 8521 (Part 1) : 2022 ISO 16321-1 : 2021	Eye and face protection for occupational use Part 1 General requirements *(first revision)*
	IS 8521 (Part 2) : 2022 ISO 16321-3 : 2021	Eye and face protection for occupational use Part 2 Additional requirements for mesh protectors *(first revision)*
(53)	1179 : 1967	Specification for equipment for eye and face protection during welding (*first revision*)
(54)	2361 : 2002	Specification for bull-dog grips (*third revision*)
(55)	11057 :1984	Specification for industrial safety nets
(56)	3016 : 1982	Code of practice for fire precautions in welding and cutting operations (*first revision*)
(57)	1084 : 2005	Specification for manila ropes (*fifth revision*)
	2266 : 2019	Steel wire ropes for general engineering purpose – Specification (*fifth revision*)
(58)	818 : 1968	Code of practice for safety and health requirements in electric and gas welding and cutting operations (*first revision*)
(59)	5916 : 2013	Constructions involving use of hot bituminous materials - Code of safety
(60)	13416	Recommendations for preventive measure against hazards at workplaces :
	(Part 4) : 1994	Timber structure
(61)	15683 : 2018	Portable fire extinguishers — Performance and construction — Specification (*first revision*)
(62)	819 : 1957	Code of practice for resistance spot welding for light assemblies in mild steel
	1261 : 1959	Code of practice for seam welding in mild steel
	3016 : 1982	Code of practice for fire precautions in welding and cutting operations (*first revision*)
	4081 : 2013	Blasting and related drilling operations - Code of Safety (*second revision*)

	4138 : 1977	Safety code for working in compressed gas (*first revision*)
	9595 : 1996	Recommendations for metal arc welding of carbon and carbon manganese steels (*first revision*)
	10178 : 1995	Recommended procedure for CO_2 gas shielded metal-arc welding of structural steels (*first* revision)
(63)	3844 : 1989	Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises (*first revision*)
	5290 : 1993	Landing valves – Specification (*third revision*)
(64)	13416 (Part 2) : 1992	Recommendation for preventive measures against hazards at work places: Fall prevention
(65)	(Part 1) : 1992	Falling material hazard prevention
(66)	(Part 3) : 1994	Disposal of debris
(67)	274	Specification for shovels
	(Part 1) : 1981	General purpose shovels (*third revision*)
	(Part 2) : 1981	Heat-treated shovels (*third revision*)
	663 : 1980	Specification for adzes (*second revision*)
	704 : 1984	Specification for crow bars and claw bars (*second revision*)
	841 : 1983	Specification for steel hammers (*second revision*)
	844	Specification for screw drivers
	(Part 2) : 1979	Dimensions (*second* revision)
	(Part 3) : 1979	Dimensions for screw drivers for recessed head screws (*second revision*)
	1630 : 1984	Specification for Mason's tools for plaster work and pointing work (*first revision*)
	1759 : 1986	Specification for *Powrahs* (*second revision*)
	1791 : 2020	General requirements for batch type concrete mixers (*third revision*)
	1930 : 2003	Woodworking tools – Chisels and gouges (*third revision*)
	1931 : 2000	Specification for engineer's files (*third revision*)
	2028 : 2004	Specification for open jaw wrenches (spanners) (*fourth revision*)
	2029 : 1998	Specification for ring wrenches (spanners) (*fourth revision*)
	2030 : 1989	Specification for box spanners (*second revision*)
	2094	Heaters for bitumen (tar) and emulsion — Specification
	(Part 1) : 2020	Bitumen heaters (*third revision*)
	(Part 2) : 2020	Bitumen sprayer *(first revision*)
	(Part 3) : 2020	Bitumen heaters (*first revision*)
	2431 : 2022	Specification for steel wheelbarrows (single-wheel type) (*first revision*)
	2438 : 2022	Specification for roller pan mixer (*first revision*)
	2505 : 2023	Immersion type concrete vibrators – General requirements (*fourth revision*)
	2506 : 2022	General requirements for concrete vibrators, screed board type (*second revision*)
	2514 : 2023	Concrete vibrating tables – Specification (*first revision*)
	2587 : 1975	Specification for pipes vices (open side type and fixed sides type) (*first revision*)

2588 : 1975	Specification for blacksmith's vices (*first revision*)
2722 : 2022	Specification for portable swing weigh batcher for concrete (single and double bucket type) (*first revision*)
2852 : 1998	Specification for carpenters augers (*first revision*)
3066 : 1965	Specification for hot asphalt mixing plants
3251(Part 1) : 2021	Asphalt paver finishers – Part 1 General requirements (*first revision*)
3251(Part 2) : 2021	Asphalt paver finisher – Specification Part 2 hydraulic *(second revision)*
3365 : 2022	Floor polishing machines – Specification (*first revision*)
3559 : 2018	Pneumatic concrete breakers – Specification (*first revision)*
3587 : 1986	Specification for rasps (*second revision*)
3650 : 1981	Specification for combination side cutting pliers (*second revision*)
3938 : 1983	Specification for electric wire rope hoists (*second revision*)
4003	Specification for pipe wrenches
(Part 1) : 1978	General purposes (*first revision*)
(Part 2) : 1986	Heavy duty (*first revision*)
4017 : 1992	Specification for carpenters squares (*first revision*)
4095 : 1991	Specification for pincers (*second revision*)
4183 : 2022	Metal hand rammers – Specification (*first revision*)
4184 : 2023	Steel Wheelbarrows (with two wheels) – Specification (*first revision*)
4508 : 1992	Specification for open ended slugging wrenches (spanners) (*first revision*)
4915 : 2024	Welder's chipping hammer — Specification (*first revision*)
5066 : 1969	Specification for glass pliers
5067 : 1969	Specification for fencing pliers
5087 : 1969	Specification for wire stripping pliers
5098 : 1969	Specification for cross cut and rip saws
5123 : 1969	Specification for tenon and dovetail saws
5169 : 1986	Specification for hack-saw frames (*first revision*)
5200 : 1998	Specification for bolt clippers (*first revision*)
5658 : 1990	Specification for snipenose pliers (*first revision*)
5663 : 1970	Specification for brick and mason's chisels
5684 : 1970	Specification for pipe vices (chain type)
5697 : 1970	Specification for ripping chisels
5889 : 2024	Vibratory plate compactor — Specification (*second revision*)
5890 : 2004	Mobile hot mix asphalt plants, light duty – Requirements (*first revision*)
5891 : 2022	Hand-Operated mortar/concrete mixer — Specification (*first revision*)
5995 : 1971	Specification for pipe grip pliers
6007 : 1971	Specification for pipe vices (hinged type)
6078 : 2017	Pliers and nippers — Engineer's and "lineman's" pliers — Dimensions and test values (*third revision)*
6087 : 1971	Specification for metal cutting shears

	6118 : 2017	Pliers and nippers - Multiple slip joint pliers - Dimensions and test values (*second revision*)
	6149 : 1984	Specification for single ended open jaw adjustable wrenches (*(first revision*)
	6375 : 1991	Specification for wood splitting wedges (*first revision*)
	6389 : 1998	Specification for combination wrenches with equal openings (*second revision*)
	6428 : 2023	Pile frame — Specification (*first revision*)
	6430 : 2023	Mobile air compressor for construction purposes — Specification (*second revision*)
	6433 : 2021	Guniting equipments – Specification (*first revision*)
	6546 : 1989	Specification for claw hammers (*first revision*)
	6836 : 1973	Specification for hand snaps and set-ups for solid rivets
	6837 : 1973	Specification for three wheel type pipe cutter
	6841 : 1973	Specification for wrecking bars
	6861 : 1973	Specification for engineers' scrapers
	6881 : 1973	Specification for link type pipe cutters
	6891 : 1973	Specification for carpenter's auger bits
	6892 : 1973	Specification for blacksmith's brick- iron
	7041 : 1973	Specification for carpenter's plain brace
	7042 : 1973	Specification for carpenter's ratchet brace
	7077 : 1973	Specification for bending bars
	7958 : 1976	Specification for hand vices
	8202 : 1999	Specification for carpenter's wooden bodied planes (*first revision*)
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(68)	7293 : 1974	Safety code for working with construction machinery
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(72)	15298 (Part 2) : 2024	Personal protective equipment – Part 2 safety footwear (ISO 20345 : 2021, MOD) (*third revision*)
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