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GROUP 3 [CED 46: National Building Code]

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समूह 3

NATIONAL BUILDING CODE OF INDIA 2005

Group 3

NATIONAL BUILDING CODE OF INDIA 2005

GROUP 3

PART 0 INTEGRATED APPROACH — PREREQUISITE FOR APPLYING PROVISIONS OF THE CODE

PART 7 CONSTRUCTIONAL PRACTICES AND SAFETY

BUREAU OF INDIAN STANDARDS

SP 7 (Group 3) : 2005

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FOREWORD

Construction programmes are interwoven in a large measure in all sectors of development, be it housing, transport, industry, irrigation, power, agriculture, education or health. Construction, both public and private, accounts for about fifty percent of the total outlay in any Five Year Plan. Half of the total money spent on construction activities is spent on buildings for residential, industrial, commercial, administrative, education, medical, municipal and entertainment uses. It is estimated that about half of the total outlay on buildings would be on housing. It is imperative that for such a large national investment, optimum returns are assured and wastage in construction is avoided.

Soon after the Third Plan, the Planning Commission decided that the whole gamut of operations involved in construction, such as, administrative, organizational, financial and technical aspects, be studied in depth. For this study, a Panel of Experts was appointed in 1965 by the Planning Commission and its recommendations are found in the 'Report on Economies in Construction Costs' published in 1968.

One of the facets of building construction, namely, controlling and regulating buildings through municipal byelaws and departmental handbooks received the attention of the Panel and a study of these regulatory practices revealed that some of the prevailing methods of construction were outmoded; some designs were overburdened with safety factors and there were other design criteria which, in the light of newer techniques and methodologies, could be rationalized; and building byelaws and regulations of municipal bodies which largely regulate the building activity in the country wherever they exist, were outdated. They did not cater to the use of new building materials and the latest developments in building designs and construction techniques. It also became clear that these codes and byelaws lacked uniformity and they were more often than not 'specification oriented' and not 'performance oriented'.

These studies resulted in a recommendation that a National Building Code be prepared to unify the building regulations throughout the country for use by government departments, municipal bodies and other construction agencies. The then Indian Standards Institution (now Bureau of Indian Standards) was entrusted by the Planning Commission with the preparation of the National Building Code. For fulfilling this task a Guiding Committee for the preparation of the Code was set up by the Civil Engineering Division Council of the Indian Standards Institution in 1967. This Committee, in turn, set up 18 specialist panels to prepare the various parts of the Code. The Guiding Committee and its panels were constituted with architects, planners, materials experts, structural, construction, electrical illumination, air conditioning, acoustics and public health engineers and town planners. These experts were drawn from the Central and State Governments, local bodies, professional institutions and private agencies. The first version of the Code was published in 1970.

After the National Building Code of India was published in 1970, a vigorous implementation drive was launched by the Indian Standards Institution to propagate the contents and use of the Code among all concerned in the field of planning, designing and construction activities. For this, State-wise Implementation Conferences were organized with the participation of the leading engineers, architects, town planners, administrators, building material manufacturers, building and plumbing services installation agencies, contractors, etc.

These Conferences were useful in getting across the contents of the Code to the interests concerned. These Conferences had also helped in the establishment of Action Committees to look into the actual implementation work carried out by the construction departments, local bodies and other agencies in different States. The main actions taken by the Action Committees were to revise and modernize their existing regulatory media, such as, specifications, handbooks, manuals, etc, as well as building byelaws of local bodies like municipalities at city and town levels, zilla parishads, panchayats and development authorities, so as to bring them in line with the provisions contained in the National Building Code of India. In this process, the Indian Standards Institution rendered considerable support in redrafting process.

Since the publication in 1970 version of the National Building Code of India, a large number of comments and useful suggestions for modifications and additions to different parts and sections of the Code were received as a result of use of the Code by all concerned, and revision work of building byelaws of some States. Based on the comments and suggestion received the National Building Code of India 1970 was revised in 1983.

Some of the important changes in 1983 version included : addition of development control rules, requirements for greenbelts and landscaping including norms for plantation of shrubs and trees, special requirements for low income housing; fire safety regulations for high rise buildings; revision of structural design section based on new and revised codes, such as Concrete Codes (plain and reinforced concrete and prestressed concrete), Earthquake Code, Masonry Code; addition of outside design conditions for important cities in the country, requirements relating to noise and vibration, air filter, automatic control, energy conservation for air conditioning; and guidance on the design of water supply system for multi-storeyed buildings.

The National Building Code of India is a single document in which, like a network, the information contained in various Indian Standards is woven into a pattern of continuity and cogency with the interdependent requirements of Sections carefully analyzed and fitted in to make the whole document a cogent continuous volume. A continuous thread of 'preplanning' is woven which, in itself, contributes considerably to the economies in construction particularly in building and plumbing services.

The Code contains regulations which can be immediately adopted or enacted for use by various departments, municipal administrations and public bodies. It lays down a set of minimum provisions designed to protect the safety of the public with regard to structural sufficiency, fire hazards and health aspects of buildings; so long as these basic requirements are met, the choice of materials and methods of design and construction is left to the ingenuity of the building professionals. The Code also covers aspects of administrative regulations, development control rules and general building requirements; fire protection requirements; stipulations regarding materials and structural design; rules for design of electrical installations, lighting, air conditioning and lifts; regulation for ventilation, acoustics and plumbing services, such as, water supply, drainage, sanitation and gas supply; measures to ensure safety of workers and public during construction; and rules for erection of signs and outdoor display structures.

Some other important points covered by the Code include 'industrialized systems of building' and 'architectural control'. The increase in population in the years to come will have a serious impact on the housing problem. It has been estimated that the urban population of India will continue to increase with such pace as to maintain the pressure on demand of accommodation for them. Speed of construction is thus of an utmost importance and special consideration has to be given to industrialized systems of building. With increased building activity, it is also essential that there should be some architectural control in the development of our cities and towns if creation of ugliness and slum-like conditions in our urban areas is to be avoided.

Since the publication of 1983 version of National Building Code of India, the construction industry has gone through major technological advancement. In the last two decades, substantial expertise has been gained in the areas of building planning, designing and construction. Also, lot of developments have taken places in the techno-legal regime and techno-financial regime, apart from the enormous experience gained in dealing with natural calamities like super cyclones and earthquakes faced by the country. Further, since the last revision in 1983 based on the changes effected in the Steel Code, Masonry Code and Loading Code as also in order to update the fire protection requirements, three amendments were brought out to the 1983 version of the Code. Considering these, it was decided to take up a comprehensive revision of the National Building Code of India.

The changes incorporated in the present Code, which is second revision of the Code, have been specified in the Foreword to each Part/Section of the Code. Some of the important changes are:

a) A new Part 0 'Integrated Approach — Prerequisite for Applying the Provisions of the Code' emphasizing on multi-disciplinary team approach for successfully accomplishing building/development project, has been incorporated.

b) New chapters on significant areas like structural design using bamboo, mixed/composite construction and landscaping have been added.

c) Number of provisions relating to reform in administration of the Code as also assigning duties and responsibilities to all concerned professionals, have been incorporated/modified. Also detailed provisions/ performance to ensure structural sufficiency of buildings, have been prescribed so as to facilitate implementation of the related requirements to help safely face the challenges during natural disasters like earthquake.

d) Planning norms and requirements for hilly areas and rural habitat planning, apart from detailed planning norms for large number of amenities have been incorporated.

e) Fire safety aspects have been distinctly categorized into fire prevention, life safety and fire protection

giving detailed treatment to each based on current international developments and latest practices followed in the country.

f) Aspects like energy conservation and sustainable development have been consistently dealt with in various parts and sections through appropriate design, usage and practices with regard to building materials, construction technologies and building and plumbing services. Renewable resources like bamboo and practices like rain water harvesting have been given their due place.

g) The latest revised earthquake code, IS 1893 (Part 1) : 2002 'Criteria for earthquake resistant design of structures: Part 1 General provisions and buildings', has been incorporated, due implementation of the provisions of which in applicable seismic zone of the country, needs to be duly adhered to by the Authorities.

The Code now published is the third version representing the present state of knowledge on various aspects of building construction. The process of preparation of the 2005 version of the Code had thrown up a number of problems; some of them were answered fully and some partially. Therefore, a continuous programme will go on by which additional knowledge that is gained through technological evolution, users' views over a period of time pinpointing areas of clarification and coverage and results of research in the field, would be incorporated in to the Code from time to time to make it a living document. It is, therefore, proposed to bring out changes to the Code periodically.

The provisions of this Code are intended to serve as a model for adoption by Public Works Departments and other government construction departments, local bodies and other construction agencies. Existing PWD codes, municipal byelaws and other regulatory media could either be replaced by the National Building Code of India or suitably modified to cater to local requirements in accordance with the provisions of the Code. Any difficulties encountered in adoption of the Code could be brought to the notice of the Sectional Committee for corrective action.

This publication forms part of the National Building Code of India 2005 and contains the following Parts:

PART 0 INTEGRATED APPROACH — PREREQUISITE FOR APPLYING PROVISIONS OF THE CODE

PART 7 CONSTRUCTIONAL PRACTICES AND SAFETY

The provisions contained in this publication which would guide the concerned professionals in the field to execute the various constructional operations in a safe and efficient manner.

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Important Explanatory Note for Users of Code

In this Code, where reference is made to 'accepted standards' in relation to material specification, testing or other related information or where reference is made to 'good practice' in relation to design, constructional procedures or other related information, the Indian Standards listed at the end of the concerned Parts/Sections may be used to the interpretation of these terms.

At the time of publication, the editions indicated in the above Indian Standards were valid. All standards are subject to revision and parties to agreements based on the Parts/Sections 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 each Part/Section, the number appearing in the first column indicates the number of the reference in that Part/Section. For example:

a) good practice [7(4)] refers to the standard given at serial number 4 of the list of standards given at the end of Part 7, that is IS 2190 : 1992 'Code of practice for selection, installation and maintenance of portable first-aid fire extinguishers (*third revision*)'.

b) good practice [7(7)] refers to the standard given at serial number 7 of the list of standards given at the end of Part 7, that is IS 3764 : 1992 'Safety code of excavation work (*first revision*)'.

c) accepted standard 7(9) refers to the standard given at serial number 9 of the list of standards given at the end of Part 7, that is IS 2925 : 1984 'Specification for industrial safety helmets (*second revision*)'.

d) accepted standard 7(18) refers to the standard given at serial number 18 of the list of standards given at the end of Part 7, that is IS 11057 : 1984 'Specification for industrial safety nets'.

e) good practice [7(37)] refers to the standard given at serial number 37 of the list of standards given at the end of Part 7, that is IS 4130 : 1991 'Safety code for demolition of buildings (*second revision*)'.

INFORMATION FOR THE USERS

For the convenience of the users, the National Building Code of India 2005 is available as a comprehensive volume as well as in the following five groups, each incorporating the related Parts/Sections dealing with particular area of building activity:

Group 1	**For Development, Building Planning and Related Aspects**	Part 0:	Integrated Approach — Prerequisite for Applying Provisions of the Code
		Part 2:	Administration
		Part 3:	Development Control Rules and General Building Requirements
		Part 4:	Fire and Life Safety
		Part 5:	Building Materials
		Part 10:	Landscaping, Signs and Outdoor Display Structures
			Section 1 Landscape Planning and Design
			Section 2 Signs and Outdoor Display Structures
Group 2	**For Structural Design and Related Aspects**	Part 0:	Integrated Approach — Prerequisite for Applying Provisions of the Code
		Part 6:	Structural Design
			Section 1 Loads, Forces and Effects
			Section 2 Soils and Foundations
			Section 3 Timber and Bamboo
			3A Timber
			3B Bamboo
			Section 4 Masonry
			Section 5 Concrete
			5A Plain and Reinforced Concrete
			5B Prestressed Concrete
			Section 6 Steel
			Section 7 Prefabrication, Systems Building and Mixed/Composite Construction
			7A Prefabricated Concrete
			7B Systems Building and Mixed/ Composite Construction
Group 3	**For Construction Related Aspects including Safety**	Part 0:	Integrated Approach — Prerequisite for Applying Provisions of the Code
		Part 7:	Constructional Practices and Safety
Group 4	**For Aspects Relating to Building Services**	Part 0:	Integrated Approach — Prerequisite for Applying Provisions of the Code
		Part 8:	Building Services
			Section 1 Lighting and Ventilation
			Section 2 Electrical and Allied Installations
			Section 3 Air conditioning, Heating and Mechanical Ventilation
			Section 4 Acoustics, Sound Insulation and Noise Control
			Section 5 Installation of Lifts and Escalators
Group 5	**For Aspects Relating to Plumbing Services including Solid Waste Management**	Part 0:	Integrated Approach — Prerequisite for Applying Provisions of the Code
		Part 9:	Plumbing Services
			Section 1 Water Supply, Drainage and Sanitation (including Solid Waste Management)
			Section 2 Gas Supply

The information contained in different groups will essentially serve the concerned professionals dealing in the respective areas.

The National Building Code of India consists of the following Parts and Sections:

NATIONAL BUILDING CODE OF INDIA

PART 0 INTEGRATED APPROACH — PREREQUISITE FOR APPLYING PROVISIONS OF THE CODE

BUREAU OF INDIAN STANDARDS

CONTENTS

FOREWORD

In order to provide safe and healthy habitat, careful consideration needs to be paid to the building construction activity. Building planning, designing and construction activities have developed over the centuries. Large number of ancient monuments and historical buildings all over the world bear testimony to the growth of civilization from the prehistoric era with the extensive use of manual labour and simple systems as appropriate to those ages to the present day mechanized and electronically controlled operations for designing and constructing buildings and for operating and maintaining systems and services. In those days those buildings were conceptualized and built by master builders with high levels of artisan skills. Technological and socio-economic developments in recent times have led to remarkable increase in demand for more and more sophistication in buildings resulting in ever increasing complexities. These perforce demand high levels of inputs from professionals of different disciplines such as architecture, civil engineering, structural engineering, functional and life safety services including special aspects relating to utilities, landscaping, etc in conceptualization, spatial planning, design and construction of buildings of various material and technology streams, with due regard to various services including operation, maintenance, repairs and rehabilitation aspects throughout the service life of the building.

This Code, besides prescribing the various provisions, also allows freedom of action to adopt appropriate practices and provides for building planning, designing and construction for absorbing traditional practices as well as latest developments in knowledge in the various disciplines as relevant to a building including computer aided and/or other modern sensors aided activities in the various stages of conceptualization, planning, designing, constructing, maintaining and repairing the buildings. India being a large country with substantial variations from region to region, this Code has endeavoured to meet the requirements of different regions of the country, both urban and rural, by taking into consideration factors, such as, climatic and environmental conditions, geographical terrain, proneness to natural disasters, ecologically appropriate practices, use of eco-friendly materials, reduction of pollution, protection and improvement of local environment and also socio-economic considerations, towards the creation of sustainable human settlements.

This Part of the Code dealing with ‘integrated approach’ is being included for the first time. It gives an overall direction for practical applications of the provisions of different specialized aspects of spatial planning, designing and construction of buildings, creation of services, and proposes an integrated approach for utilizing appropriate knowledge and experience of qualified professionals right from the conceptualization through construction and completion stages of a building project and indeed during the entire life cycle. The ‘integrated approach’ should not only take care of functional, aesthetic and safety aspects, but also the operational and maintenance requirements. Also, cost optimization has to be achieved through proper selection of materials, techniques, equipment installations, etc. Further, value engineering and appropriate management techniques should be applied to achieve the aim set forth for the purpose of construction of a building fully meeting the specified and implied needs of spatial functions, safety and durability aspects, life and health safety, comfort, services, etc in the building.

The aim of the ‘integrated approach’ is to get the maximum benefit from the building and its services in terms of quality, timely completion and cost-effectiveness. In the team approach which is an essential pre-requisite for integrated approach, the aim clearly is to maximize the efficiency of the total system through appropriate optimization of each of its sub-systems. In other words, in the team, the inputs from each of the professional disciplines have to be so optimized that the total system’s efficiency becomes the maximum. It may be re-emphasized that maximizing the efficiencies of each sub-system may not necessarily assure the maximization of the efficiency of the total system. It need hardly to be stated that specified or implied safety will always get precedence over functional efficiency and economy. Further, progressive approach such as that relating to the concept of intelligent buildings would be best taken care of by the ‘integrated approach’ as laid down in this Part.

Quality systems approach and certification thereunder covering the various dimensions brought out above may go a long way in achieving the above goal of real integrated approach.

NATIONAL BUILDING CODE OF INDIA

PART 0 INTEGRATED APPROACH — PREREQUISITE FOR APPLYING PROVISIONS OF THE CODE

1 SCOPE

This Part covers guidelines to be followed for judicious implementation of the provisions of various Parts/ Sections of the Code.

2 TERMINOLOGY

2.0 For the purpose of this Part, the following definitions and those given in Part 1 'Definitions' 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 or an agency to act on its behalf; hereinafter called the 'Authority'.

2.2 Building — Any structure for whatsoever purpose and of whatsoever materials constructed and every part thereof whether used as human habitation or not and includes foundation, plinth, walls, floors, roofs, chimneys, plumbing and building services, fixed platforms, *VERANDAH*, balcony, cornice or projection, part of a building or anything affixed thereto or any wall enclosing or intended to enclose any land or space and signs and outdoor display structures. Tents/ *SHAMIANAHS/PANDALS*, tarpaulin shelters, etc, erected for temporary and ceremonial occasions shall not be considered as building.

2.3 Owner — Person or body having a legal interest in land and/or building thereon. This includes free holders, leaseholders or those holding a sub-lease which both bestows a legal right to occupation and gives rise to liabilities in respect of safety or building condition.

In case of lease or sub-lease holders, as far as ownership with respect to the structure is concerned, the structure of a flat or structure on a plot belongs to the allottee/ lessee till the allotment/lease subsists.

NOTE — For the purpose of the Code, the word 'owner' will also cover the generally understood terms like 'client', 'user', etc.

3 GENERAL

3.1 Buildings, shall be classified as Residential, Educational, Institutional, Assembly, Business, Mercantile, Industrial, Storage and Hazardous in groups and sub-division as classified in Part 4 'Fire and Life Safety'.

For further sub-classification of buildings and various related provisions thereof with respect to administration; development control rules and general building requirements; building materials; fire and life safety; structural design; constructional practices and safety; building and plumbing services; and landscaping, signs and outdoor display structures, other parts/sections of the Code may be referred to.

3.2 The scope of various Parts/Sections of the Code which cover detailed provisions on different aspects of development of land/building construction activity, are given in Annex A, with a view to providing an overview for the users of the Code.

4 TEAM APPROACH

A land development/building project comprises the following major stages:

a) Location/siting,
b) Conceptualization and planning,
c) Designing and detailing,
d) Construction/execution, and
e) Maintenance and repair.

Each stage necessarily requires professionals of many disciplines who should work together as a well coordinated team to achieve the desired product delivery with quality, in an effective manner.

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 the project:

a) Architect,
b) Civil engineer,
c) Structural engineer,
d) Electrical engineer,
e) Plumbing engineer,
f) Fire protection engineer,
g) HVAC engineer,
h) Environment specialist,
j) Town planner,
k) Urban designer,
m) Landscape architect,
n) Security system specialist,
p) Interior designer,
q) Quantity surveyor,
r) Project/construction manager, and
s) Other subject specialist(s).

4.1 Design Team

In building projects various aspects like form; space planning; aesthetics; fire and life safety; structural adequacy; plumbing services; lighting and natural ventilation; electrical and allied installations; air conditioning, heating and mechanical ventilation; acoustics, sound insulation and noise control; installation of lifts and escalators; building automation; data and voice communication; other utility services installations; landscape planning and design; urban planning; etc need to be kept in view right at the concept stage. The project requiring such multi-disciplinary inputs need a co-ordinated approach among the professionals for proper integration of various design inputs. For this, and to take care of the complexities of multi-disciplinary requirements, a design team of professionals from required disciplines shall be constituted at the appropriate stage. Here, it is desirable that the multi-disciplinary integration is initiated right from the concept stage. The team shall finalize the plan. The composition of the team shall depend on the nature and magnitude of the project. Design is an evolutionary and participatory process, where participation of owner constitutes a very important input at all stages, and the same shall be ensured by the design team.

To ensure proper implementation of the design, the design team, may be associated during the construction/ execution stage.

4.2 Project Management and Construction Management Teams

The objective of project management or construction management is primarily to achieve accomplishment of project in accordance with the designs and specifications in a stipulated time and cost framework, with a degree of assurance prior to commencement and satisfaction on accomplishment.

For large projects, separate teams of experienced professionals from the required disciplines may be constituted for project management and for construction management depending upon the complexities of the project. However, for smaller projects these teams may be combined. The teams shall be responsible for day-to-day execution, supervision, quality control, etc and shall ensure inter-disciplinary co-ordination during the construction stage. The team shall be responsible to achieve satisfactory completion of the project with regard to cost, time and quality. Some members of the design team may also be included in the project management team and/or associated actively during the project execution stage. It is important that leaders and members of project management/construction management teams, depending on the size and complexity of the project, are carefully selected considering their qualification, experience and expertise in these fields.

4.3 Operation and Maintenance Team

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 co-ordination have to be executed in such a manner as not only to cause least inconvenience to the user but also to ensure that there is no mismatch or damage to the structure, finishings, fittings and fixtures. For carrying out routine maintenance/repair jobs, utilization of the services of trained technicians preferably having multi-disciplinary skills should be encouraged.

Special repairs, rehabilitation and retrofitting are specialized jobs which demand knowledge of the existing structure/installations. Association of concerned specialists may be helpful for these works.

The Operation and Maintenance Team may also be known as Asset Management or Estate Management Team.

5 PLANNING, DESIGNING AND DEVELOPMENT

5.1 The main functions of design team (*see* **4.1**) constituted for the planning, designing and development, are as under:

a) Formalization of design brief in consultation with the owner.
b) Site investigation/survey.
c) Preparation of alternative concept designs.
d) Selection of a concept in consultation with and with the consent of owner.
e) Sizing the system.
f) Development of design, covering :
    1) Integration of architecture, structure and services,
    2) Synthesis of requirements of each discipline, and
    3) Interaction with each other and with the owner.
g) Preparation of preliminary designs and drawings and obtaining owner's approval.
h) Preparation of preliminary cost estimates for approval of owner.
j) Preparation of work-breakdown structure and programme for pre-construction activities.
k) Assisting client to obtain approvals of the Authority.
m) Preparation of detailed specification and

construction working drawings with integration of engineering inputs of all concerned disciplines.

n) Preparation of detailed design of each discipline for various services.

p) Peer review/proof checking of the drawings/ designs in case of important projects, depending upon their complexity and sensitivity.

q) Preparation of detailed cost estimate.

r) Obtaining final approval of client.

s) Preparation of bill of quantities, specifications and tender documents.

5.2 The following considerations, as may be applicable to the project, may be considered during planning, notwithstanding other relevant aspects specifically prescribed in concerned parts/sections of this Code; these considerations in general are with the objective of addressing to the important issues like environmental protection, energy conservation, cultural issues, creating barrier free built-environment, safety aspects, etc, all of these leading towards sustainable development, and have to be applied with due regard to the specific requirements of size and type of project:

a) Geoclimatic, geological and topographical features.

b) Varied sociological pattern of living in the country.

c) Effective land use to cater to the needs of the society in a most convenient manner.

d) Modular planning and standardization to take care of future planning giving due consideration to the specified planning controls.

e) Emphasis on daylight utilization, natural ventilation, shielding, and window area and its disposition; daylighting to be supplemented with an integrated design of artificial lighting.

f) Optimum utilization of renewable energy sources duly integrated in the overall energy system design; with consideration of active and passive aspects in building design including thermal performance of building envelope.

g) Rain water harvesting, and use of appropriate building materials considering aspects like energy consumption in production, transportation and utilization, recyclability, etc for promoting sustainable development.

h) Requisite mandatory provisions for handicapped persons.

j) Acoustical controls for buildings and the surroundings.

k) Promotion of artwork in buildings, specially buildings of importance.

m) Due cognizance of recommendations of the Archeological Survey of India with regard to national monuments and construction in archeologically important sites.

n) Due cognizance of relevant provisions of applicable coastal zone regulation act.

p) Conservation of heritage structures and areas.

q) Environmental and social impact analysis.

r) Design of services with emphasis on aspects of energy efficiency, environment friendliness and maintainability.

s) Integrated waste management.

t) Voice and data communication, automation of building services, and intelligent building; use of security and surveillance system in important and sensitive buildings, such as, access control for the people as well as for vehicle.

u) Interlinking of fire alarm system, fire protection system, security system, ventilation, electrical systems, etc.

v) Analysis of emergency power, standby power requirement and captive power systems.

w) Cost optimization through techniques like value engineering.

y) Adoption of innovative technologies giving due consideration to constructability and quality aspects.

z) Instrumentation of buildings and monitoring and use of information so generated to effect improvements in planning and design of future building projects.

6 CONSTRUCTION/EXECUTION (ACTUALIZATION)

6.1 The main functions of the teams (*see* **4.2**) constituted for Project Management/Construction Management may be, to :

a) specify criteria for selection of constructors;

b) specify quality control, quality audit system and safety system;

c) short-list constructors;

d) have pre-bid meetings with the intending constructors;

e) receive and evaluate tenders;

f) select constructors;

g) execution and supervision;

h) monitor quality, time and cost control;

j) prepare/certify the completion (as-built) drawings; and

k) ensure availability of operation manuals for field use.

6.2 Apart from the specific provisions laid down in the concerned Parts/Sections of the Code, the following considerations, as may be applicable to the project concerned, shall be given due attention:

a) Adopting scientific principles of construction management, quality management, cost and time control.

b) Engagement of executing and supervising agencies, which meet the specified norms of skills, specialization, experience, resourcefulness, etc for the work.

c) Ensuring inter-disciplinary co-ordination during construction.

d) Contract management and techno-legal aspects.

e) Completion, commissioning and trial run of installations/equipments and their operation and maintenance through the suppliers/other teams, where necessary.

f) Make available shop drawings as well as as-built drawings for the building and services.

g) Arrange all maintenance and operation manual from the concerned suppliers/ manufacturers.

6.3 The team of professionals (*see* **4.2**) shall work and monitor the project activities for successful construction/execution of the project with regard to cost, time, quality and safety.

7 OPERATION AND MAINTENANCE

7.1 The team of professionals (*see* **4.3**) shall set up a system of periodic maintenance and upkeep of constructed buildings.

7.2 The operation and maintenance team shall be responsible for preparation/application of operation and maintenance manual, and draw maintenance schedule/frequencies and guidelines for maintenance personnel. Apart from the specific provisions laid down in concerned Parts/Sections of the Code, the following, as may be applicable to the project concerned shall additionally be taken into account:

a) Periodic validation of buildings by competent professionals through inspection of the buildings in respect of structural safety and safety of electrical and other installations and ensuring that all fire safety equipments/ systems are in proper working condition.

b) Preparation of preventive maintenance schedules for all installations in the building and strictly following the same; the record of the preventive maintenance to be properly kept.

c) Ensuring inter-disciplinary co-ordination during maintenance and repairs; deployment of trained personnel with multi-disciplinary skills to be encouraged.

d) Condition survey of structures and installations, identification of distress of various elements and initiating plans for rehabilitation/retrofitting well in time.

7.3 The proposals for rehabilitation/retrofitting should be prepared after detailed investigations through visual inspection, maintenance records and testing as required and got executed through specialized agencies under the guidance and supervision of competent professionals.

ANNEX A

(*Clause* 3.2)

BRIEF DETAILS OF THE COVERAGE OF VARIOUS PROVISIONS UNDER DIFFERENT OTHER PARTS/SECTIONS OF THIS CODE

A-1 PART 1 DEFINITIONS

It lists the terms appearing in all the Parts/Sections of the Code. However, some common definitions are reproduced in this Part also.

A-2 PART 2 ADMINISTRATION

It covers the administrative aspects of the Code, such as applicability of the Code, organization of building department for enforcement of the Code, procedure for obtaining development and building permits, and responsibility of the owner and all professionals involved in the planning, design and construction of the building.

A-3 PART 3 DEVELOPMENT CONTROL RULES AND GENERAL BUILDING REQUIREMENTS

It covers the development control rules and general building requirements for proper planning and design at the layout and building level to ensure health safety, public safety and desired quality of life.

A-4 PART 4 FIRE AND LIFE SAFETY

It covers the requirements for fire prevention, life safety in relation to fire, and fire protection of buildings. The Code specifies planning and construction features and fire protection features for all occupancies that are necessary to minimize danger to life and property.

A-5 PART 5 BUILDING MATERIALS

It covers the requirements of building materials and components, and criteria for accepting new or alternative building materials and components.

A-6 PART 6 STRUCTURAL DESIGN

This Part through its seven sections provides for structural adequacy of buildings to deal with both internal and external environment, and provide guidance to engineers/structural engineers for varied usage of material/technology types for building design.

A-6.1 Section 1 Loads, Forces and Effects

It covers basic design loads to be assumed in the design of buildings. The live loads, wind loads, seismic loads, snow loads and other loads, which are specified therein, are minimum working loads which should be taken into consideration for purposes of design.

A-6.2 Section 2 Soils and Foundations

It covers structural design (principles) of all building foundations, such as, raft, pile and other foundation systems to ensure safety and serviceability without exceeding the permissible stresses of the materials of foundations and the bearing capacity of the supporting soil.

A-6.3 Section 3 Timber and Bamboo

A-6.3.1 *Section 3A Timber*

It covers the use of structural timber in structures or elements of structures connected together by fasteners/ fastening techniques.

A-6.3.2 *Section 3B Bamboo*

It covers the use of bamboo for constructional purposes in structures or elements of the structure, ensuring quality and effectiveness of design and construction using bamboo. It covers minimum strength data, dimensional and grading requirements, seasoning, preservative treatment, design and jointing techniques with bamboo which would facilitate scientific application and long-term performance of structures. It also covers guidelines so as to ensure proper procurement, storage, precautions and design limitations on bamboo.

A-6.4 Section 4 Masonry

It covers the structural design aspects of unreinforced load bearing and non-load bearing walls, constructed using various bricks, stones and blocks permitted in accordance with this Section. This, however, also covers provisions for design of reinforced brick and reinforced brick concrete floors and roofs. It also covers guidelines regarding earthquake resistance of low strength masonry buildings.

A-6.5 Section 5 Concrete

A-6.5.1 *Section 5A Plain and Reinforced Concrete*

It covers the general structural use of plain and reinforced concrete.

A-6.5.2 *Section 5B Prestressed Concrete*

It covers the general structural use of prestressed concrete. It covers both work carried out on site and the manufacture of precast prestressed concrete units.

A-6.6 Section 6 Steel

It covers the use of structural steel in general building construction including the use of hot rolled steel sections and steel tubes.

A-6.7 Section 7 Prefabrication, Systems Building and Mixed/Composite Construction

A-6.7.1 *Section 7A Prefabricated Concrete*

It covers recommendations regarding modular planning, component sizes, prefabrication systems, design considerations, joints and manufacture, storage, transport and erection of prefabricated concrete elements for use in buildings and such related requirements for prefabricated concrete.

A-6.7.2 *Section 7B Systems Building and Mixed/ Composite Construction*

It covers recommendations regarding modular planning, component sizes, joints, manufacture, storage, transport and erection of prefabricated elements for use in buildings and such related requirements for mixed/composite construction.

A-7 PART 7 CONSTRUCTIONAL PRACTICES AND SAFETY

It covers the constructional planning, management and practices in buildings; storage, stacking and handling of materials and safety of personnel during construction operations for all elements of a building and demolition of buildings. It also covers guidelines relating to maintenance management, repairs, retrofitting and strengthening of buildings. The objective can be best achieved through proper coordination and working by the project management and construction management teams.

A-8 PART 8 BUILDING SERVICES

This Part through its five elaborate sections on utilities provides detailed guidance to concerned professionals/ utility engineers for meeting necessary functional requirements in buildings.

A-8.1 Section 1 Lighting and Ventilation

It covers requirements and methods for lighting and ventilation of buildings.

A-8.2 Section 2 Electrical and Allied Installations

It covers the essential requirements for electrical and allied installations in buildings to ensure efficient use of electricity including safety from fire and shock. This Section also includes general requirements relating to lightning protection of buildings.

A-8.3 Section 3 Air Conditioning, Heating and Mechanical Ventilation

This Section covers the design, construction and installation of air conditioning and heating systems and equipment installed in buildings for the purpose of providing and maintaining conditions of air temperature, humidity, purity and distribution suitable for the use and occupancy of the space.

A-8.4 Section 4 Acoustics, Sound Insulation and Noise Control

It covers requirements and guidelines regarding planning against noise, acceptable noise levels and the requirements for sound insulation in buildings with different occupancies.

A-8.5 Section 5 Installation of Lifts and Escalators

It covers the essential requirements for the installation, operation, maintenance and also inspection of lifts (passenger lifts, goods lifts, hospital lifts, service lifts and dumb-waiter) and escalators so as to ensure safe and satisfactory performance.

A-9 PART 9 PLUMBING SERVICES

This Part through its two sections gives detailed guidance to concerned professionals/plumbing engineers with regard to plumbing and other related requirements in buildings.

A-9.1 Section 1 Water Supply, Drainage and Sanitation (Including Solid Waste Management)

It covers the basic requirements of water supply for residential, business and other types of buildings, including traffic terminal stations. This Section also deals with general requirements of plumbing connected to public water supply and design of water supply systems.

It also covers the design, layout, construction and maintenance of drains for foul water, surface water and sub-soil water and sewage; together with all ancillary works, such as connections, manholes and inspection chambers used within the building and from building to the connection to a public sewer, private sewer, individual sewage-disposal system, cess-pool, soakaway or to other approved point of disposal/ treatment work. It also includes the provisions on solid waste management.

A-9.2 Section 2 Gas Supply

It covers the requirements regarding the safety of persons and property for all piping uses and for all types of gases used for fuel or lighting purposes in buildings.

A-10 PART 10 LANDSCAPING, SIGNS AND OUTDOOR DISPLAY STRUCTURES

A-10.1 Section 1 Landscape Planning and Design

It covers requirements of landscape planning and design with the view to promoting quality of outdoor built environment and protection of land and its resources.

A-10.2 Section 2 Signs and Outdoor Display Structures

It covers the requirements with regard to public safety, structural safety and fire safety of all signs and outdoor display structures including the overall aesthetical aspects of imposition of signs and outdoor display structures in the outdoor built environment.

NATIONAL BUILDING CODE OF INDIA

PART 7 CONSTRUCTIONAL PRACTICES AND SAFETY

BUREAU OF INDIAN STANDARDS

CONTENTS

SECTION 5 SAFETY IN DEMOLITION OF BUILDINGS

FOREWORD

This Part of the Code emphasizes the importance of carrying out all constructional operations in a safe and efficient 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.

Planning the various constructional 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 constructional 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.

The first version of this Part was prepared in 1970, which was subsequently revised in 1983. In the first revision, 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.

As a result of experience gained in implementation of 1983 version of this part and feedback received as well as in view of formulation of new standards in the field of constructional practices and safety and revision of some existing standards, a need to revise this Part was felt. This revision has, therefore, been prepared to take care of these aspects. The significant changes incorporated in this revision include:

a) The Section 1 Constructional Practices have been revamped and now includes the Planning and Management aspects.
b) The provisions with regard to stacking and storage of building materials and components have been updated and comprehensively covered in line with IS 4082 : 1996. This revision now also covers provisions for materials like stones, blocks, roof tiles, partially prefabricated wall and roof components, cinder, aluminium section, cast iron and aluminium sheets, plastic sheets, doors and windows, etc.
c) Provisions on constructional practices using bamboo have been included.
d) Provisions of safety requirements of hoists/lifts for worker during construction have been added.
e) Provisions with regard to safety at work site have been detailed incorporating aspects like preventive measures, such as, falling material hazards prevention, fall prevention, disposal of debris, fire protection, etc.
f) Provisions regarding safety management at work sites have been added.
g) A new section on ‘Maintenance management, repairs, retrofitting and strengthening of buildings’ has been added, covering aspects like maintenance management, prevention of cracks, and repairs and seismic strengthening of buildings.
h) Safety provisions with respect to demolition of buildings have been updated.
j) Reference to all the concerned Indian Standards have been updated.

Bamboo is a versatile renewable resource having low gestation period, characterized by high strength, low mass and ease of working with simple tools. Resilience coupled with lightness makes it suitable for housing in earthquake-prone and disaster-prone areas. It has the capacity to absorb more energy and shows larger deflections before collapse and as such is safer under earth tremors. In this revision of this Part, therefore, provisions on construction using bamboo have been incorporated. The structural design aspects are covered in Part 6 ‘Structural Design, Section 3 Timber and Bamboo, 3B Bamboo’.

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

IS No.	*Title*
3696	Safety code for scaffolds and ladders:
(Part 1) : 1987	Scaffolds
(Part 2) : 1991	Ladders
3764 : 1992	Code of practice for excavation work (*first revision*)
4082 : 1996	Recommendations on stacking and storage of construction materials and components at site (*second revision*)
4130 : 1991	Safety code for demolition of buildings (*second revision*)
4912 : 1978	Safety requirements for floor and wall openings, railing and toe boards (*first revision*)
5121 : 1969	Safety code for piling and other deep foundations
5916 : 1970	Safety code for construction involving use of hot bituminous materials
7205 : 1974	Safety code for erection of structural steel work
7969 : 1975	Safety code for handling and storage of building materials
8989 : 1978	Safety code for erection of concrete framed structures
13415 : 1992	Safety code for protective barrier in and around buildings
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
13430 : 1992	Code of practice for safety during additional construction and alteration to existing buildings

A reference to SP 62 : 1992 'Handbook on building construction practices (excluding electrical works)' 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.

NATIONAL BUILDING CODE OF INDIA

PART 7 CONSTRUCTIONAL PRACTICES AND SAFETY

1 SCOPE

This Part of the Code covers the constructional planning, management and practices in buildings; storage, stacking and handling of materials and safety of personnel during construction operations for all elements of a building and demolition of buildings. It also covers guidelines relating to maintenance management, repairs, retrofitting and strengthening of buildings.

SECTION 1 CONSTRUCTIONAL PRACTICES

2 PLANNING, MANAGEMENT AND PRACTICES

2.1 Planning Aspects

Construction planning aspects aim to identify and develop various stages of project execution on site which should be consistent with the management considerations. Planning aspects evolve out of the objectives of project and requirements of the final completed constructed facility. These objectives could relate to the final 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, equipments, human and environmental) and monitoring system to ensure that the practices are appropriately aligned. Adequate knowledge about pre-construction phase evolution of project, especially related to customer's requirements, is an essential prerequisite for construction planning.

2.1.1 *Preconstruction Phase*

2.1.1.1 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.

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

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

2.1.1.4 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.

2.1.1.5 Constructional 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.

2.1.1.6 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 constructional practices.

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

2.1.1.8 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, suitable design and field operations should be adapted or redefined in anticipation of these aspects. Some of these aspects are:

a) Site layout which enables accessibility in adverse weather.
b) Adequate protected storage for weather sensitive materials/equipments.
c) Protections to personnel from extreme hot/ control 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, staple of false work in extreme wind conditions (gusts).
f) Adequate lighting for shorter days in winter/ night work.
g) Design for early enclosure.

2.1.2 *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.

In construction phases, the resources could be categorized as materials, manufactured products, equipments 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 and infrastructure facilities. 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) (*see* Annex A) may be used.

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

2.1.3 *Construction Phase*

2.1.3.1 *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. Safety management is one of the important components of site management.

2.1.3.2 *Site layout*

The layout of the construction site should be carefully planned keeping in view the various requirements to 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 equipments 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 equipments (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 workforce 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.

2.1.3.3 *Access for fire fighting equipment vehicles*

Access for fire fighting equipment shall be provided to the construction site at the start of construction and maintained until all construction work is completed.

2.1.3.3.1 Free access from the street to fire hydrants/ static water tanks, where available, shall be provided and maintained at all times.

2.1.3.3.2 No materials for construction shall be placed within 3 m of hydrants/static water tanks.

2.1.3.3.3 During building operations, free access to permanent, temporary or portable first-aid fire fighting equipment shall be maintained at all times.

2.1.3.4 *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.

2.1.3.5 *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 equipments like cranes and piling equipments;
h) Effect of weather; and
j) Minimum time to be spent below ground level working.

2.1.4 *Scope Management*

Construction management efforts should ensure that the project features and functions that characterise the project scope remain as established during the design finalization stage. Accordingly, construction phase practices need to be oriented to manage the project scope. As a part of overall project scope management functions, the processes of scope planning, scope definition and scope verification are associated with the preconstruction phase of the project. The scope monitoring and the change control are critical to the construction phase leading to serious implications on the time and cost aspects. In this respect, consolidated brief of the project established at the end of the design completion is an essential reference for scope baseline.

2.2 Construction Management

Construction phase of the project transfers the project conceived on paper in the form of plans and designs, into reality by use of resources like materials, machines and men through one or more construction agencies. To fulfil the construction scope with quality, in time and under safe conditions within a reasonable cost, it is desired that the project is planned for managing construction for amalgamation of above resources for their optimum use and its continuous monitoring. Agencies managing the supervision and/or construction are desired to plan and document a management system with clear cut responsibilities and for managing various parameters like scope, time, quality, health, safety and environment and cost for implementation, monitoring and control for their effectiveness. This may be preferably inline with proven National/International documentation system covering all aspects of monitoring and controls. Various parameters to be managed during construction are as below.

2.2.1 *Time Management*

Considering the importance of time in a project, it is desirable that project is completed in the defined time schedule to get its fruitful benefits. The system planned should cover total schedule of completion with one or more construction agencies, number of vendors, identification of total resources, timely availability of all inputs, including critical ones, its processing during construction of a project. The system should include a periodic review of a project with all parameters as well as catch up plans in case of delay identified for controls and reporting from time to time. The system planned should preferably be computer friendly and simple to follow for implementation, monitoring and controls and for reporting from time-to-time.

2.2.2 *Quality Management*

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

2.2.3 *Health, Safety and Environement*

Each project affects the safety and health of the workmen and surroundings during construction. Various activities having impact on health, safety and environment need to be identified with their likely effect and proposed preventive corrective actions, together with the concerned statutory obligations. The system planned for health, safety and environment shall address and cover the above including use of personnel protective equipments by all concerned, and reporting

on their monitoring and controls during project implementation.

2.2.4 *Cost Management*

To keep the project under viable proposition, it is desired that cost of the project during construction are monitored and controlled through a documentation system. The various parameters which may affect the basic cost, escalations, cost due to variation in scope and quantities, etc need to be monitored at a defined frequency. The system planned may be in line with a proven cost control method or similar in nature and cost incurred vis-a-vis cost sanctioned and cost anticipated to be reported and controlled from time to time.

2.3 Construction Control and Practices

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

2.3.2 *Construction of all Elements*

Construction of all elements of a building shall be in accordance with good practice [7(1)]. Constructional aspects using bamboo shall be as given in **2.3.3**. 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', and quality of building materials/components used shall be in accordance with Part 5 'Building Materials'.

2.3.3 *Construction Using Bamboo*

2.3.3.1 Bamboo being a versatile resource characterized by high strength, low mass and ease of working with simple tools, it is desirable to increasingly make appropriate use of this material. Design of structures using bamboo shall be done in accordance with Part 6 'Structural Design, Section 3 Timber and Bamboo, 3B Bamboo'. For construction using bamboo, some of the important constructional provisions given in **2.3.3.2** to **2.3.3.6** shall be followed.

2.3.3.2 *Working finishing*

2.3.3.2.1 Bamboo can be cut and split easily with very simple hand tools. Immature bamboos are soft, pliable and can be moulded to desired shape. It takes polish and paint well.

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

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

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

2.3.3.2.4 *Foundations*

Bamboo in direct contact with ground, bamboo on rock or preformed concrete footing, bamboo incorporated into concrete or bamboo piles may form the foundation structure (*see* Fig. 1).

2.3.3.2.5 *Floors*

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

2.3.3.2.6 *Jointing Techniques*

The jointing techniques in construction using bamboo shall be in accordance with Part 6 'Structural Design, Section 3 Timber and Bamboo, 3B Bamboo'.

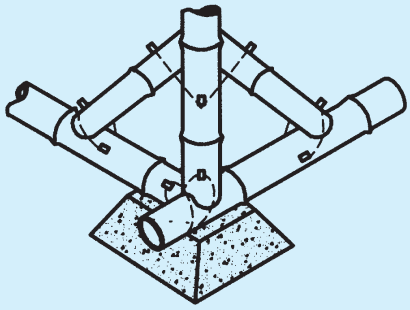
2.3.4 *Low Income Housing*

For low income housing, appropriate planning and selection of building materials and techniques of construction have to be judiciously done and applied in practice. Requirements of low income housing specified in Part 3 'Development Control Rules and General Building Requirements', shall be followed. However, all requirements regarding structural safety, health safety and fire safety shall be in accordance with this Code.

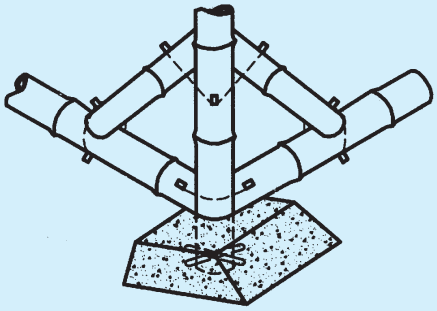
2.3.5 *Site Preparation*

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.

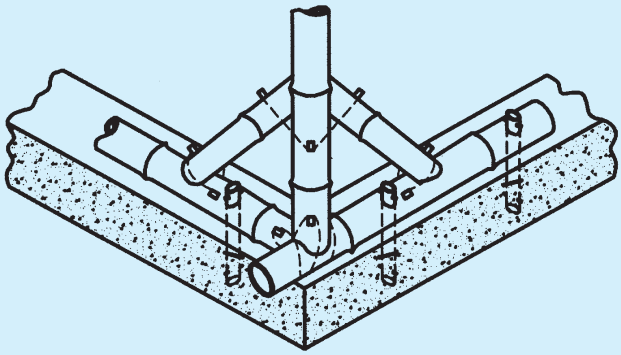
Temporary buildings for construction offices and storage shall be so located as to cause the minimum fire hazards and shall be constructed from non-combustible materials as far as possible.



1A BAMBOO ON PREFORMED CONCRETE FOOTINGS



1B BAMBOO INCORPORATED INTO CONCRETE FOOTINGS (SINGLE POST FOOTING)



1C BAMBOO OUT OF GROUND CONTACT ON STRIP FOOTINGS OF CONCRETE (LARGE DIAMETER THICK WALLED BAMBOO WITH CLOSELY SPACED NODES TO BE USED)

FIG. 1 BAMBOO FOUNDATIONS

2.3.6 *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, row-lock (rat trap) bond in masonry, stretcher bond in filler slab and filler slab 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.

SECTION 2 STORAGE, STACKING AND HANDLING PRACTICES

3 GENERAL

3.1 Planning and Storage Layout

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

3.1.2 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.

3.1.3 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.

3.1.4 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.

3.1.5 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.

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

3.2 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.

3.3 Manual Handling

When heavy materials have to be handled manually each workman shall be instructed by his foreman or supervisor for the proper method of handling such materials. Each workman shall be provided with suitable equipment for his personal safety as necessary. Supervisors shall also take care to assign enough men to each such job depending on the weight and the distance involved.

3.4 Protection Against Fire and Other Hazards

3.4.1 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(2)] shall be followed. Explosives like detonators shall be stored in accordance with the existing regulations of *Indian Explosives Act*.

3.4.2 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.

3.4.3 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.

4 STORAGE, STACKING AND HANDLING OF MATERIALS

4.1 The storage stacking and handling of materials generally used in construction shall be as given in **4.2** to **4.31**, which have been summarized in the form of a check list in Annex B. Exposure to asbestos fibres/ dust is known to be harmful to health of human beings. Prescribed guidelines in accordance with good practice [7(3)] shall be followed for handling and usage asbestos cement products.

4.2 Cement

a) *Storage and Stacking* — Cement shall be stored at the work site in a building or a shed which is dry, leakproof 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.

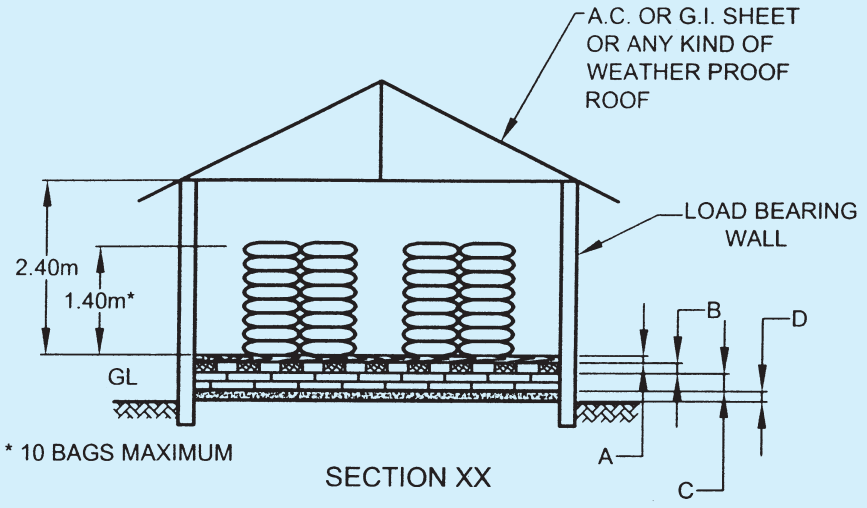
Cement received in bags shall be kept in such a way that the bags are kept free from the possibility of any dampness or moisture coming in contact with them. Cement bags shall be stacked off the floor on wooden planks in such a way as to keep them about 150 mm to 200 mm clear above the floor. The floor 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 alround between the exterior walls and the stacks (*see* Fig. 2). In the stacks the cement bags shall be kept close together to reduce circulation of air as such 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 off.

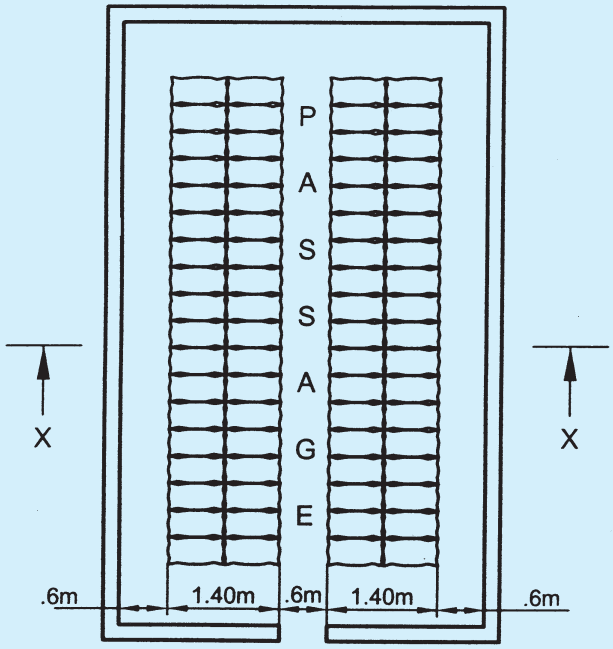
The height of stack shall not be more than 10 bags to prevent the possibility of lumping up under pressure. The width of the stack shall be not more than four bags length or 3 metres. In stacks more than 8 bags high, the cement bags shall be arranged alternately length-wise and cross-wise so as to tie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

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

Cement in gunny bags, paper bags and polyethylene bags shall be stored separately.

In case cement is received in drums, these





A = Planks
B = Wooden Battens
C = 150 Dry Bricks in Two Layer or Lean Cement Concrete
D = 150 Consolidated Earth

Fig. 2 Typical Arrangement in Cement Godown

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 plan. Proper access shall be provided for the replacement of silos.

Different types of cements shall be stacked and stored separately.

b) *Handling* — Hooks shall not be used for handling cement bags unless specifically permitted by the engineer-in-charge.

For information regarding bulk handling of cement, *see* **4.4**.

4.3 Lime

4.3.1 *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 alround 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* **4.4**.

4.3.2 *Hydrated Lime*

a) *Storage and stacking* — Hydrated lime is generally supplied in containers, such as jute bags lined with polyethylene or craft paper bags. It should be stored in a building to protect the lime from dampness and to minimize warehouse deterioration.

The building should be with a concrete floor and having least ventilation to eliminate draughts through the walls and roof. In general, the recommendations given in **4.2** 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* **4.4**.

4.3.3 *Dry Slaked Lime*

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

b) *Handling — See* **4.4**.

4.4 Handling of Cement and Lime

Workmen, 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.

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.

4.5 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, up to a height of 1.2 m. A distance of about 0.8 m shall be kept between two adjacent stacks.

b) *Bricks* — Bricks shall be stacked in regular tiers as and when they are unloaded to minimize breakage and defacement. These shall not be dumped at site. In the case of bricks made from clays containing lime *KANKAR*, the bricks in stack should be thoroughly soaked in water (docked) to prevent lime bursting.

Bricks shall be stacked on dry firm ground. For proper inspection of quality and east in counting, the stacks shall be 50 bricks long, 10 bricks high and not more than 4 bricks in width, the bricks being placed on edge, two at a time along the width of the stack. Clear distance between adjacent stacks shall not be less than 0.8 m. Bricks of each truck load shall be put in one stack. Bricks of different types, such as, clay bricks, clay fly ash bricks, fly ash lime bricks, sand lime (calcium silicate) bricks shall be stacked separately. Bricks of different classifications from strength consideration and size consideration (such as, conventional and modular) shall be stacked separately. Also bricks of different types, such as, solid, hollow and perforated shall be stacked separately.

c) *Blocks* — Blocks are available as hollow and solid concrete blocks, hollow and solid light weight concrete blocks, autoclaved aerated concrete blocks, concrete stone masonry blocks and soil based blocks. Blocks shall be unloaded one at a time and stacked in regular tiers to minimize breakage and defacement. These shall not be dumped at site. The height of the stack shall not be more than 1.2 m, the length of the stack shall not be more 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.

4.6 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 more than 1 m.

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.

4.7 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 over hang 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.

4.8 Pulverized Fuel Ash/Fly Ash

a) *Storage and Stacking* — Fly ash 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.

b) *Handling — See* **4.4**.

4.9 Cinder

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

4.10 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 piles 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 workmen are not injured by rails, straps, etc, attached to the used timber. This applies particularly to planks and formwork for shuttering.

4.11 Bamboo

4.11.1 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.

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

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

4.11.4 Prophylactic treatment of bamboo during storage prevents losses due to fungi and insects even under open storage. Following chemicals are found suitable at the coverage rate of 24 litres per tonne.

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

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.

4.12 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 **4.5**(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 component by holding a specified points so that the stresses due to handling are minimized.

4.13 Steel

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

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

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

Structural steel of different sections, sizes and lengths shall be stored separately. It shall be

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

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

4.14 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 slided over each other, to protect the anodizing layer.

4.15 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 form loose cement and mortar by suitable covering, such as tarpaulin. The tarpaulin shall be hung loosely on temporary framing to permit circulation of air to prevent moisture condensation.

All timber and other lignocellulosic material based frames and shutters shall be stored in a dry and clean covered space away from any infestation and dampness. The storage shall preferably be in well-ventilated dry rooms. The frames shall be stacked one over the other 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 an 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.

4.16 Roofing Materials

4.16.1 Roofing sheets shall be stored and stacked in such a manner as not to damage them in any way. Damaged sheets shall not be stacked with sound materials. All damaged sheets shall be salvaged as early as possible.

4.16.2 *Asbestos Cement Sheet*

a) *Storage and stackings* — Asbestos cement sheets shall be stacked to a height of not more than one metre on firm and level ground, with timber or other packing beneath them. If stacked in exposed position, they shall be protected from damage by the winds.

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 workmen. Asbestos cement sheets shall be lowered or raised gently and not thrown.

4.16.3 *CGI Sheets*

a) *Storage and stacking* — CGI sheets shall be stacked in not more than 100 bundles per stack built solidly, each bundle consisting of 10 sheets. Bundles shall be so laid that the corrugations run in the same directions in every course. One end of the stack shall be raised by 100 mm to 150 mm to allow water flowing freely. If the sheets are not to be used immediately, these shall be stacked under roof cover.

b) *Handling* — In bulk handling of CGI sheets, workmen shall be provided with suitable hand protection.

4.17 Boards

4.17.1 *Gypsum Boards*

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

b) *Handling — See* **4.11.2**(b).

4.17.2 *Plywood, Fibre Board, Particle Board, Block Board, etc*

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

The board shall be stacked in a solid block in a clear vertical alignment. The top sheet of each stack shall be suitably weighed down to prevent warping, wherever necessary.

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

4.18 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 gases as they produce harmful order in their vicinity.

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 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, workmen shall lift the sheets and carry them flat to avoid sharp bends or folds of the sheets.

4.19 Glass Sheets

a) *Storage and Stacking* — 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* — Workmen 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 workmen.

4.20 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 length-wise and cross-wise 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 the same class and size.

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 conveying to the actual site and shall be carried on shoulders. Fittings shall be handled individually.

4.21 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.

4.22 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 or 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 become brittle in very cold weather.

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

4.23 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.

4.24 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, workmen 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 **4.18**(a) shall be followed.

4.25 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* — Ventilation adequate 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 is 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(4)].

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

4.26 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 three tiers. Leaky drums shall be segregated. Empty drums shall be stored in pyra midal stacks neatly in rows.

b) *Handling — See* **19.3.1.2** and **19.3.4**.

4.27 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.

4.28 Flammable Materials

a) *Storage and Stacking* — In addition to the requirements as laid down in **3.4**, 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.

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.

Workmen 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.

4.29 Water

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

4.30 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 spillings, 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.

4.31 Other Materials

Polymeric materials such as coatings, sheetings, reflective surfacings/sheetings, 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.

4.32 Special Considerations

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

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

4.32.3 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.

4.32.4 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(4)]. It is desirable that a minimum of two extinguishers are provided at each such location.

4.32.5 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.

4.32.6 *House Keeping*

Stairways, walkways, scaffolds, and accessways 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.

4.32.7 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.

5 UNLOADING RAIL/ROAD WAGONS AND MOTOR VEHICLES

5.1 Loading and Unloading Rail/Road Wagons

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

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

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

5.1.4 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.

5.1.5 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.

5.2 Loading and Unloading from Motor Vehicles

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

5.2.2 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.

5.3 Handling Heavy/Long Items

5.3.1 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.

5.3.2 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 workmen.

5.3.3 Similar procedure as outlined in **5.3.2** shall be followed for manual unloading of long or heavy items.

SECTION 3 SAFETY IN CONSTRUCTION OF ELEMENTS OF A BUILDING

6 GENERAL

6.1 The provisions of this Section shall apply to the erection/alterational of the various parts of a building or similar structure. The construction of the different elements shall conform to **2.3.2**.

6.2 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 workmen 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.

6.3 Safety Management

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

6.3.2 Notwithstanding the guidelines given in **6.3.1**, 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 Act***,** 1996 and the Rules/Regulations framed thereunder.

7 TERMINOLOGY

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

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

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

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

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

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

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

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

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

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

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

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

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

8 TEMPORARY CONSTRUCTION, USE OF SIDE WALLS AND TEMPORARY ENCROACHMENTS

8.1 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.

8.1.1 Temporary structure referred in **8.1** 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.

8.2 For detailed information regarding fire safety aspects in respect of construction, location, maintenance and use of temporary structures [mentioned in **8.1.1**(a)] including *PANDALS* used by public for outdoor assembly, reference may be made to good practice [7(5)].

8.3 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.

8.4 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.

9 TESTING

9.1 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' {*see also* good practice [7(6)]}.

9.1.1 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.

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

10 INSPECTION AND RECTIFICATION OF HAZARDOUS DEFECTS

10.1 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.

10.2 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').

10.3 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 FOUNDATIONS

11.1 General

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

11.2 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.

In driven piles vibration is set up which may cause damage to adjoining structures or service lines depending on the nature of soil condition and the construction standard of such structures and service lines. Possible extent of all such damages shall be ascertained in advance, and operation and mode of driving shall be planned with appropriate measures to ensure safety.

Where in the vicinity of a site where bored or driven piling works are to be carried out there are old structures which are likely to be damaged, tell-tales shall be fixed on such structures to watch their behaviour and timely precautions taken against any undesirable effect.

11.3 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').

11.4 Before carrying out any excavation work/pile driving, the position, depth and size of underground structures, such as water pipes, mains, cables or other services in the vicinity to the proposed work, may be obtained from the Authority to prevent accidents to workmen engaged in excavation work and calamities for the general public.

Prior to commencement of excavation detailed data of the type of soils that are likely to be met with during excavation shall be obtained and the type of protective works by way of shoring timbering, etc, shall be decided upon for the various strata that are likely to be encountered during excavation. For detailed information regarding safety requirements during excavation reference may be made to good practice [7(7)].

12 GENERAL REQUIREMENTS AND COMMON HAZARDS DURING EXCAVATION

12.1 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.

12.2 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.

12.2.1 *Other Surcharges*

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

12.3 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 workmen during excavation. Effect of climatic variations and moisture content variations on the materials under excavation shall be constantly watched and precautions taken, where necessary, immediately to prevent accidents at work site.

12.4 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.

12.5 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.

12.5.1 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.

12.6 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.

12.7 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').

12.8 Fencing and Warning Signals

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

12.9 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.

12.10 Vibrations from Nearby Sources

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

12.11 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.

13 PILING AND OTHER DEEP FOUNDATIONS

13.1 General

13.1.1 *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.

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

13.1.3 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.

13.1.4 Working in compressed air, in case of deep foundations, requires several precautions to be observed to safeguard the workmen against severe hazards to life, compressed air disease and related ailments. For detailed information regarding safety requirements, reference may be made to good practice [7(8)].

13.2 Piling Rig

13.2.1 Pile drivers shall not be erected in dangerous proximity to electric conductors. If two pile drivers are erected at one place these shall be separated by a distance at least equal to the longest leg in either rig.

13.2.2 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.

13.2.3 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.

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

13.2.4.1 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.

13.2.5 Exposed gears, fly wheels, etc, shall be fully enclosed.

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

13.2.6.1 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.

13.2.7 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.

13.2.8 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.

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

13.2.10 Motor gearing, transmission, electrical wiring and other dangerous parts of hoisting appliances should be provided with efficient safe guards. 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.

13.2.10.1 When loads have to be inclined:

a) they shall be adequately counter-balanced, and

b) the tilting device shall be secured against slipping.

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

13.2.12 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.

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

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

13.2.15 Wherever steam boilers are used, the safety regulations of boilers shall be strictly followed and safety valves shall be adjusted to 7N/cm^2 in excess of working pressure accurately.

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

13.2.17 All checks as given in the Indian Standards and any manuals issued by the manufacturers shall be carried out.

13.3 Operation of Equipment

13.3.1 Workers employed in the vicinity of pile drivers shall wear helmets conforming to accepted standards [7(9)].

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

13.3.3 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.

13.3.4 Before a good pile is hoisted into position it shall be provided with an iron ring or cap over the driving end to prevent brooming. When creosoted wood piles are being driven, adequate precautions shall be taken, such as the provision of personal protective equipment and barrier creams, to prevent workers receiving eye or skin injuries from splashes of creosote.

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

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

14 WALLS

14.1 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.

14.2 Scaffold

Properly designed and constructed scaffolding built by competent workmen shall be provided during the construction of the walls to ensure the safety of workers. The scaffolding may be of timber, metal or bamboo sections and the materials in scaffolding shall be inspected for soundness, strength, etc, at site by the engineer-in-charge prior to erection of scaffolds. Steel scaffolds intended for use in normal building construction work shall conform to accepted standards [7(10)]. Bamboo and timber scaffolds shall be properly tied to the junctions with coir ropes of sufficient strength or mechanical joints to ensure that joints do not give way due to the load of workmen and material. Joining the members of scaffolds only with nails shall be prohibited as they are likely to get loose under normal weathering conditions. In the erection or maintenance of tall buildings, scaffoldings shall be of 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. The platforms, gangways and runways provided on the scaffoldings shall be of sufficient strength and width to ensure safe passage for the workmen working on the scaffolding. The joints provided in these gangways, platforms, etc, shall be such as to ensure a firm foot-hold to the workmen. Where necessary, cross bars shall be provided to the full width of gangway or runway to facilitate safe walking. For detailed information regarding safety requirements for erection, use and dismantling of scaffolds, reference may be made to good practice [7(11)].

14.2.1 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.

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

14.3 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 one metre 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 precautions, 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 30 cm to side in order to reach a larger area from a single setting of the ladder. Instead, the user shall get down and shift the ladder to the required position.

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

Wooden ladders shall be inspected at least once in a month for damage and deterioration. Close visual inspection is recommended in preference to load testing. This condition is particularly applicable to rope and bamboo ladders wherein fraying of ropes and damage to bamboo is likely to occur due to materials falling on them. When a ladder has been accidentally dropped it shall be inspected by the engineer-in-charge prior to re-use. Overhead protection shall be provided for workmen under ladder. For detailed information regarding safety requirements for use of ladders, reference may be made to good practice [7(12)].

14.4 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.

14.4.1 *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(13)]. 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.

14.4.2 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 **14.4.1** or as required by the conditions.

14.5 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.

15 COMMON HAZARDS DURING WALLING

15.1 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 workmen

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 workmen.

15.2 Haulage of Materials

15.2.1 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.

15.2.2 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.

15.3 Electical Hazards

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

15.4 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.

15.4.1 Where extensive use of blow torch or other flame is anticipated scaffoldings, gangways, etc, shall be constructed with fire resistant materials. A portable dry powder extinguisher of 3 kg capacity shall be kept handy.

15.5 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.

15.6 Fragile Materials

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

16 ROOFING

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

16.2 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 workmen. 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 workmen in lower area. In slopes of more than 30° to the horizontal, the workmen shall use ladders or other safety devices to work on the roof.

16.3 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 workmen shall be allowed to proceed to work on a sloping roof, only if the engineer-in-charge has satisfied himself that the workmen are not likely to slip due to wet conditions.

16.4 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.

16.5 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.

16.6 Guarding of Floor Openings and Floor Holes

16.6.1 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 the adequate strength and it should be hinged in place. When the cover is not in place, the floor hole shall be constantly attended by some one or shall be protected by a removable railing.

16.6.2 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 can not walk directly into the opening.

16.6.3 *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) or all open sides, except where there is entrance to ramp, stair-way, or fixed ladder. The railing shall be provided with a toe board beneath the open sides wherever:

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(13)].

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

17.1 Handling of Plant

17.1.1 *Mixers*

17.1.1.1 All gears, chains and rollers of mixers shall be properly guarded. If the mixer has a charging skip the operator shall ensure that the workmen 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.

17.1.1.2 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.

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

17.1.2 *Cranes*

17.1.2.1 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.

17.1.2.2 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.

17.1.2.3 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 **4.23**(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.

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

17.1.2.5 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.

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

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

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

17.1.2.9 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.

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

17.1.2.11 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.

17.1.2.12 A standard code of hand signals shall be adopted in controlling the movements of the crane, and both the driver and the signaler shall be thoroughly familiar with the signals.

The driver of the crane shall respond to signals only from the appointed signaler but shall obey stop signal at any time no matter who gives it.

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

17.1.3 *Trucks*

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

17.1.4 *Concrete Pumps (Air Compressor Operated)*

Safety requirements in accordance with good practice [7(14)] shall be followed.

17.2 Formwork

17.2.1 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* good practice [7(6)] }.

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

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

17.2.4 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.

17.2.5 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.

17.2.6 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.

17.2.7 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.

17.2.8 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.

17.2.9 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.

17.2.10 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.

17.2.11 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 starta.

17.2.12 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.

17.2.13 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.

17.2.14 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 workmen actually engaged in removing the formwork shall be allowed in the area during these operations. Those engaged in removing the formwork shall wear helmets, gloves and heavy soled shoes and approved safety belts if adequate footing is not provided above 2 m level. While cutting any tying wires in tension, care shall be taken to prevent backlash which might hit a workman.

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

17.3 Ramps and Gangways

17.3.1 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 workmen. Ramps and gangways shall be kept free from grease, mud, snow or other slipping hazards or other obstructions leading to tripping and accidental fall of a workman.

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

17.4 Materials Hoists

17.4.1 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.

17.4.2 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.

17.4.3 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.

17.4.4 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.

17.4.5 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.

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

17.4.7 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).

17.4.8 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.

17.4.9 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 signalling shall be employed.

17.4.10 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.

17.4.11 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.)

17.4.12 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.

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

17.4.14 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.

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

17.5 Prestressed Concrete

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

17.5.2 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.

17.5.3 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.

17.5.4 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.

17.5.5 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 workmen from working behind the jacks when the stressing operation is in progress.

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

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

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

17.6 Erection of Prefabricated Members

17.6.1 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°.

17.6.2 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.

17.6.3 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.

17.6.4 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.

17.6.5 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.

17.6.6 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.

17.7 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.

17.8 Structural Connections

17.8.1 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.

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

17.8.3 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.

17.8.4 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.

17.9 General

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

18 ADDITIONAL SAFETY REQUIREMENTS FOR ERECTION OF STRUCTURAL STEEL WORK

18.1 Safety Organization

The agency responsible for erecting the steel work should analyze the proposed erection scheme for safety; the erection scheme should cover safety aspects right from the planning stage up to the actual execution of the work.

18.2 Safety of Workpersons

18.2.1 *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.

18.2.1.1 The helmets shall be worn properly and at all times during the work and shall conform to the accepted standards [7(9)].

18.2.1.2 The safety goggles shall be used while performing duties which are hazardous to eye like

drilling, cutting and welding. The goggles used shall conform to the accepted standards [7(15)] and should suit individual workers.

18.2.1.3 The welders and gas cutters shall be equipped with proper protective equipment like gloves, safety boots, aprons and hand shields [*see* accepted standard 7(15)]. The filter glass of the hand shield shall conform to the accepted standards [7(16)] and should be suitable to the eyes of the particular worker.

18.2.1.4 When the work is in progress, the area shall be cordoned off by barricades to prevent persons from hitting against structural components, or falling into excavated trenches or getting injured by falling objects.

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

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

18.2.2 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.

18.2.2.1 Split-end eye anchors shall only be used in good, solid rock.

18.2.2.2 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.

18.2.3 When a number of trusses or deep girders is loaded in one car or on one truck, all but one being lifted shall be tied back unless they have been tied or braced to prevent their falling over and endangering men unloading.

18.2.4 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.

18.2.5 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.

18.2.6 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 be 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.

18.2.7 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 one metre 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.

18.2.8 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.

18.2.9 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 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.

18.2.10 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 good practice [7(17)]. 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.

18.2.11 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.

18.2.11.1 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.

18.2.11.2 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.

18.2.12 During the erection of tall buildings, it is desirable to use nylon nets at a height of 3 m to 4 m to provide safety to men. The safety net should be made from man or machine-made fibre ropes which are UV stablized and conforming to the acceptable standard [7(18)].

18.2.13 *Safety Against Fire*

A fire protection procedure is to be set up if there is to be any flame cutting, burning, heating, rivetting 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(19)].

18.2.13.1 The workers should be instructed not to throw objects like hot rivets, cigarette stubs, etc, around.

18.2.13.2 Sufficient fire extinguishers shall be placed at strategic points. Extinguishers shall always be placed in cranes, hoists, compressors and similar places. Where electrical equipments are involved, CO_2 or dry powder extinguishers shall be provided {*see also* good practice [7(4)]}.

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

18.2.15 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(20)] shall be used for guying.

18.2.16 *Lifting Appliances*

Precautions as laid down in **17.1.2** shall be followed.

18.2.17 *Slinging*

18.2.17.1 Chains shall not be joined by bolting or wiring links together. They shall not be shortened by tying knots. A chain in which the links are locked, stretched or do not move freely shall not be used. The chain shall be free of kinks and twists. Proper eye splices shall be used to attach the chain hooks.

18.2.17.2 Pulley blocks of the proper size shall be used to allow the rope free play in the sheave grooves and to protect the wire rope from sharp bends under load. Idle sling should not be carried on the crane hook alongwith a loaded sling. When idle slings are carried they shall be hooked.

18.2.17.3 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.

18.2.18 *Rivetting Operations*

18.2.18.1 *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.

18.2.18.2 *Rivetting dollies*

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

18.2.18.3 *Rivetting 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.

18.2.18.4 *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 already for quenching the fire during rivetting operations and to prevent fires when working near inflammable materials.

18.2.19 *Welding and Gas Cutting*

18.2.19.1 For safety and health requirements in electric gas welding and cutting operations, reference may be made to good practice [7(21)]. The recommendations given in **18.2.19.2** to **18.2.19.4** are also applicable.

18.2.19.2 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.

18.2.19.3 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.

18.2.19.4 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.

18.3 Safety of Structure

18.3.1 *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.

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

19 MISCELLANEOUS ITEMS

19.1 Staircase Construction

While staircase is under construction, depending on the type of construction, namely, concrete or brickwork, etc, suitable precautions shall be taken by way of support, formworks, etc, to prevent any collapse. Workmen or any other person shall not be allowed to use such staircases till they are tested and found fit for usage by the Authority/engineer-in-charge. Till the permanent handrails are provided, temporary provisions like ropes, etc, shall be provided on staircases prior to commencement of use of such staircases.

19.2 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 precent 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.

19.3 Construction Involving the Use of Hot Bituminous Tar Materials

19.3.1 *Safety Programme*

19.3.1.1 *General*

On all major works, an experienced and competent foreman or supervisor shall be placed 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 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.

19.3.1.2 *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.

19.3.1.3 *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 such materials are not 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 form extinguisher conforming to accepted standards [7(21)] shall be kept in readiness on the work site.

19.3.2 *Sprayer, Spreader/Paver*

19.3.2.1 *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.

19.3.2.2 *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.

19.3.3 *Equipment for Heating of Bitumen and Tars*

19.3.3.1 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.

19.3.3.2 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.

19.3.3.3 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.

19.3.3.4 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.

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

19.3.3.6 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.

19.3.3.7 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.

19.3.3.8 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.

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

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

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

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

19.3.4 *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.

19.3.5 *Bitumen Plants*

Safety requirements shall be in accordance with good practice [7(22)].

19.4 Timber Structure

Preventive measures against hazards in work places involving construction of timber structures shall be taken in accordance with good practice [7(23)].

20 FINISHES

20.1 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.

20.1.1 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.

20.1.2 A 5 kg dry powder fire extinguisher conforming to acceptable standards [7(23)] shall be kept handy.

20.1.3 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.

20.1.4 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 alongwith the containers.

20.1.5 Some paints/polishing and finishing materials are injurious to the health of workmen. Adequate protective clothing, respiratory equipment, etc, shall be provided for the use of workmen during such operations where necessary.

21 FRAGILE FIXTURES

21.1 It shall be ensured that sufficient number of workmen and equipment are provided to carry the fragile fixtures like sanitary fittings, glass panes, etc, to prevent injury to workmen due to accidental dropping of such fixtures.

22 SAFETY IN SPECIAL OPERATIONS

22.1 Safety in compressed airwork, drilling, blasting and welding operations shall be in accordance with good practice [7(25)].

23 ELECTRICAL INSTALLATIONS AND LIFTS

23.1 Temporary Electrical Wiring

23.1.1 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 workmen. 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.

23.1.2 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 shall be provided near the switch board.

23.2 Permanent Electrical Installations

Besides the fire safety measures for electrical installations covered under **23.1**, safety in electric installations in buildings and installations of lifts shall be in accordance with Part 8 'Building Services, Section 2 Electrical and Allied Installations and Section 5 Installation of Lifts and Escalators'.

24 GENERAL REQUIREMENTS

24.1 Sanitation

a) Adequate toilet facilities shall be provided for the workmen 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.

e) An adequate supply of drinking water shall be provided, and unless connected to a municipal water supply, samples of the water shall be tested at frequent intervals by the Authority.

f) Washing facilities shall be installed, and when practicable shall be installed, and when practicable shall be connected to municipal water supply and shall discharge to a sewer.

g) Natural or artificial illumination shall be provided.

24.2 Fire Protection

24.2.1 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.

24.2.1.1 All fire extinguishers shall be maintained in a serviceable condition at all times in accordance with good practice [7(4)] and all necessary guidelines regarding fire protection at workplaces followed in accordance with good practice [7(2)].

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

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

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

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

24.2.2.1 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.

24.2.2.2 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.

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

24.2.2.4 Evaluation facilities and fire exits should be provided at all locations susceptible to fire hazards.

24.2.3 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 **24.2.3.1** to **24.2.3.4**.

24.2.3.1 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.

24.2.3.2 The standpipe (landing valve/internal fire hydrant) and its installation shall conform to the accepted standards [7(26)].

24.2.3.3 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.

24.2.3.4 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.

24.2.4 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.

24.2.5 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.

24.2.6 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.

24.2.7 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.

24.2.8 *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.

24.2.8.1 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.

24.3 Clothing

24.3.1 It shall be ensured that the clothes worn by the workmen 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.

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

24.3.3 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.

24.4 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(27)].

24.5 Falling Materials Hazard Prevention

Preventive measures against falling materials hazards in work places shall be taken in accordance with good practice [7(28)].

24.6 Disposal of Debris

Preventive measures against hazards relating to disposal of debris shall be taken in accordance with [7(29)].

25 CONSTRUCTION MACHINERY

25.1 Specification and requirements of construction machinery used in construction or demolition work shall conform to accepted standards [7(30)].

25.2 For safety requirements for working with construction machinery, reference may be made to good practice [7(31)].

25.3 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.

SECTION 4 MAINTENANCE MANAGEMENT, REPAIRS, RETROFITTING AND STRENGTHENING OF BUILDINGS

26 MAINTENANCE MANAGEMENT

26.1 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.

26.2 Terminology

For the purpose of this Section, the following definitions shall apply.

26.2.1 *Maintenance* — The combination of all technical and associated administrative actions intended to retain an item in or restore it to a state in which it can perform its required function.

26.2.2 *Maintenance Management* — The organization of maintenance within an agreed policy. Maintenance can be seen as a form of 'steady state' activity.

26.2.3 *Building Fabric* — Elements and components of a building other than furniture and services.

26.2.4 *Building Maintenance* — Work undertaken to maintain or restore the performance of the building fabric and its services to provide an efficient and acceptable operating environment to its users.

26.2.5 *House Keeping* — The routine recurring work which is required to keep a structure in good condition so that it can be utilized at its original capacity and efficiency along with proper protection of capital investment, throughout its economic life.

26.2.6 *Owner* — Person or body having a legal interest in a building. This includes freeholders, leaseholders or those holding a sub-lease which both bestows a legal right to occupation and gives rise to liabilities in respect of safety or building condition.

In case of lease or sub-lease holders, as far as ownership with respect to the structure is concerned, the structure of a flat or structure on a plot belongs to the allottee/ lessee till the allotment/lease subsists.

26.2.7 *Confined Space* — Space which may be inadequately ventilated for any reason and may result in a deficiency of oxygen, or a build-up of toxic gases, e.g. closed tanks, sewers, ducts, closed and unventilated rooms, and open topped tanks particularly where heavier than air gases or vapours may be present.

26.3 Building Maintenance

26.3.1 *General*

Any building (including its services) when built has certain objectives and during its total economic life, it has to be maintained. Maintenance is a continuous process requiring a close watch and taking immediate remedial action. It is interwoven with good quality of house keeping. It is largely governed by the quality of original construction. The owners, engineers,

constructors, occupants and the maintenance agency are all deeply involved in this process and share a responsibility. Situation in which all these agencies merge into one is ideal and most satisfactory.

There are two processes envisaged, that is, the work carried out in anticipation of failure and the work carried out after failure. The former is usually referred to as preventive maintenance and the latter as corrective maintenance. The prime objective of maintenance is to maintain the performance of the building fabric and its services to provide an efficient and acceptable operating environment to its users.

26.3.1.1 Maintenance in general term can be identified in the following broad categories.

a) *Cleaning and servicing* — This is largely of preventive type, such as checking the efficacy of rain water gutters and servicing the mechanical and electrical installations. This covers the house keeping also.

b) *Rectification and repairs* — This is also called periodical maintenance work undertaken by, say, annual contracts and including external replastering, internal finishing etc.

c) *Replacements* — This covers major repair or restoration such as re-roofing or re-building defective building parts.

26.3.2 *Factors Affecting Maintenance*

26.3.2.1 Maintenance of the buildings is influenced by the following factors:

a) *Technical factors* — These include age of building, nature of design, material specifications, past standard of maintenance and cost of postponing maintenance.

b) *Policy* — A maintenance policy ensures that value for money expended is obtained in addition to protecting both the asset value and the resource value of the buildings concerned and owners.

c) *Financial and economics factors* — (*see* **26.9**).

d) *Environmental* — All buildings are subject to the effects of a variety of external factors such as air, wind precipitation, temperature etc. which influence the frequency and scope of maintenance.

The fabric of building can be adversely affected as much by the internal environment as by the elements externally. Similar factors of humidity, temperature and pollution should be considered. Industrial buildings can be subject to many different factors subject to processes carried out within. Swimming pool structures are vulnerable to the effects of chlorine used in water.

e) *User* — The maintenance requirements of buildings and their various parts are directly related to the type and intensity of use they receive.

26.3.2.2 *Influence of design*

The physical characteristics, the life span and the aesthetic qualities of any building depend on the considerations given at the design stage. All buildings, however well designed and conscientiously built, will require repair and renewal as they get older.

However, for better performance of the building envelop, the following are the ways to minimize troubles at the later stage.

a) Minimize defects during construction and design.

b) Detail and choose materials during construction so that the job of maintenance is less onerous.

26.3.2.2.1 In addition to designing a building for structural adequacy, consideration should also be given to environmental factors such as moisture, natural weathering, corrosion and chemical action, user wear and tear, pollution, flooding, subsidence, earthquake, cyclones etc.

26.3.2.2.2 A list of common causes for maintenance problems is given in Annex C for guidance. However, no such list is likely to be entirely comprehensive.

26.3.3 *Maintenance Policy*

The policy should cover such items as the owner's anticipated future requirement for the building taking account of the building's physical performance and its functional suitability. This may lead to decisions regarding:

a) the present use of the building anticipating any likely upgradings and their effect on the life cycles of existing components or engineering services; and

b) a change of use for the building and the effect of any conversion work on the life cycles of existing components or engineering services.

26.3.4 *Maintenance Work Programmes*

The programming of maintenance work can affect an owner or his activities in the following ways:

a) maintenance work should be carried out at such times as are likely to minimize any adverse effect on output or function.

b) programme should be planned to obviate as far as possible any abortive work.

This may arise if upgrading or conversion work is carried out after maintenance work has been completed or if work such as rewiring is carried out after redecorations.

c) any delay in rectifying a defect should be kept to a minimum only if such delay is likely to affect output or function. The cost of maintenance increases with shortening response times.

d) maintenance work, completed or being carried out should comply with all statutory and other legal requirements.

26.3.5 *Maintenance Guides*

An owner responsible for a large number of buildings may have established procedures for maintenance. When an owner is responsible for the maintenance of only one building or a small number of buildings, the preparation of a guide tailored to suit each particular building, can offer significant advantages. Such a guide should take into account the following:

a) type of construction and residual life of the building, and

b) environment and intensity of use (*see* **26.3.2**).

The guide may form part of a wider manual covering operational matters.

26.3.6 *Planning of Maintenance Work*

Work should take account of the likely maintenance cycle of each building element and be planned logically, with inspections being made at regular intervals. Annual plans should take into account subsequent years' programmes to incorporate items and to prevent additional costs. It should be stressed that the design of some buildings can lead to high indirect costs in maintenance contracts and therefore, careful planning can bring financial benefits. Decisions to repair or replace should be taken after due consideration.

26.3.7 *Feed Back*

26.3.7.1 Feed back is normally regarded as an important procedure of providing information about the behaviour of materials and detailing for the benefit of the architect/engineer designing new buildings, which will result in lessening maintenance costs. It is an equally valuable source of information for the persons responsible for maintenance. Every maintenance organization should develop a sample way of communicating its know how, firstly for benefit of others in the organization and secondly for the benefit of the building industry as a whole. There should be frank and recorded dialogue on an on-going basis between those who occupy and care for buildings and those who design and construct them.

26.3.7.2 Feed back should aim at the following:

a) User satisfaction,

b) Continuous improvement, and

c) Participation by all.

26.3.7.3 *Source of information*

The information on feed back can be obtained from the following:

a) Occupants,

b) Inspections,

c) Records, and

d) Discussions.

26.3.8 *Means of Effecting Maintenance*

26.3.8.1 *Responsibility*

Some maintenance work will be carried out by the occupier of a building or by the occupier's representative. In the case of leasehold or similar occupation not all maintenance may be the responsibility of occupier. Responsibility of common areas may be clearly defined.

26.3.8.2 Maintenance work sub-divided into major repair, restoration, periodical and routine or day-to-day operations will be undertaken by one of the following:

a) Directly employed labour,

b) Contractors, and

c) Specialist contractors under service agreement or otherwise.

26.3.8.3 The merits of each category for typical maintenance work must be considered because optimum use of resources appropriate to tasks in a given situation is an important element of policy.

26.3.8.4 The success of contracting out depends on the nature of the services, conditions in which contracting is undertaken (the tendering process), how the contract is formulated and subsequent monitoring of service quality. The important consideration in the decision to contract out is whether a contractor can ensure a socially desirable quantity and quality of service provision at a reasonable cost to the consumers.

26.4 Access

26.4.1 *General*

All maintenance activities including any preliminary survey and inspection work require safe access and in some situations this will have to be specially designed. Maintenance policy, and maintenance costs, will be much influenced by ready or difficult access to the fabric and to building services. Special precautions and access provisions may also need to be taken for roof

work or for entry into confined spaces such as ducts or voids.

26.4.2 *Access Facilities*

26.4.2.1 Permanent accessibility measures should be provided at the design stage only for all the areas for safe and proper maintenance. It is a matter on which those experienced in the case of the building can make an important contribution at design stage in the interest of acceptable maintenance costs.

26.4.2.2 A wide variety of temporary access equipment may appropriately be provided for maintenance work, ranging from ladders to scaffoldings or powered lift platforms.

26.4.2.3 Wherever possible it is better to provide permanent access facilities such as fixed barriers, ladders, and stairways. When such permanent access facilities are provided necessary arrangement may be included in maintenance plans for their regular inspection, maintenance and testing.

26.4.2.4 All personnel employed for carrying out maintenance should be provided with the necessary protective clothing and equipment and instructed in its use.

26.4.2.5 When physical access is not possible in situations such as wall cavities, drains etc, inspections may be made with the aid of closed circuit television or optical devices such as endoscopes.

26.4.3 *Access to Confined Spaces*

26.4.3.1 *Ventilation*

Special precautions need to be taken when entering a confined space. Such confined spaces should be adequately ventilated, particularly before being entered, to ensure that they are free from harmful concentrations of gases, vapours other airborne substances and that the air is not deficient in oxygen.

26.4.3.2 *Lighting*

Good lighting is necessary in order that maintenance work can be carried out satisfactorily. This is particularly important in confined spaces. When the normal lighting is inadequate it should be supplemented by temporary installations. These should provide general and spot illumination as appropriate.

26.5 Records

26.5.1 *General*

Good records can save owners and users/occupiers much unnecessary expense and reduce potential hazards in exploration work when faults arise.

26.5.2 *Use of Building Records*

26.5.2.1 All personnel involved in the maintenance of the building should be made aware of the existence of the building records.

26.5.2.2 Known hazardous areas should be explicitly marked on the records as well as being marked on site and should be pointed out to such personnel together with any system of work adopted for use in such areas.

26.5.2.3 Records are of value only if they are kept up to date and arrangements for this should be included in any provision that may be made for records.

26.5.2.4 Records should be readily accessible for use and the place of storage should take into account the form of the records and the conditions needed to keep them from damage of any kind. It is recommended that a duplicate set of records is kept in a secure place other than building itself and is kept up to date.

26.5.3 Following should be typical contents of the maintenance records:

a) A brief history of property, names and addresses of consultants and contractors.
b) Short specifications, constructional processes, components, material finishes, hidden features, special features etc.
c) "As built" plans and as subsequently altered with sections, elevations and other detailed drawings.
d) Foundation and structural plans/sections such as concrete reinforcement drawings.
e) Detail specification of all materials incorporated, for example, concrete mix, species and grades of timber etc. Potentially hazardous materials and types or methods of construction that under some circumstances may become hazardous may be identified.
f) Information on house keeping and routine maintenance with details of internal and external surfaces and decorations, schedule of cleaning, inspection and maintenance.
g) Means of operating mechanical, electrical and plumbing installations.
h) Description of renovations, extensions, adaptations and repair to each elements.
j) All plant, machinery and propriety articles including manufacturers trade literature and instructions for installation, use and maintenance.
k) Methods of work used in construction such as assembly of prefabricated units.
m) All information related to fire such as:

1) Location and service arrangements of all fire alarm and call points;
2) Location and service arrangements of all extinguishers, hose reels and other fire fighting installations;
3) Location of all fire compartment walls, doors, floors and screens;
4) Location of all areas of exceptional fire hazard;
5) Fire escape routes;
6) Details of application of any fire protection treatment; and
7) Location details and description of any installation for smoke control or protection of escape routes.

n) There should be a wall chart showing at a glance the various operations which have to be undertaken. Line drawings of buildings are always useful.

p) Records of security measures should be known to authorized personnel only.

q) Where no records exist, information should be slowly built up as it becomes available during the course of maintenance work.

r) Use of computers for storing information may be preferred.

26.5.4 *Mechanical Records*

26.5.4.1 *Documentation*

Documentation should record the following as installed:

a) the location, including level if buried, of all public service connections (for example, fuel gas and cold water supplies) together with the points of origin and termination, size and materials of pipes, line pressure and other relevant information;

b) the layout, location and extent of all piped services showing pipe sizes, together with all valves for regulation, isolation and other purposes as well as the results of all balancing, testing and commissioning data;

c) the location, identity, size and details of all apparatus and all control equipment served by, or associated with, each of the various services together with copies of any test certificates for such apparatus where appropriate. The information with respect to size and details may be presented in schedule form;

d) the layout, location and extent of all air ducts showing dampers and other equipment, acoustic silencers, grilles, diffusers or other terminal components. Each duct and each terminal component should be marked with its size, the air quantity flowing and other relevant balancing data; and

e) the location and identity of each room or space housing plant, machinery or apparatus.

26.5.4.2 *Drawings*

Drawings should record the following as installed:

a) detailed general arrangements of boiler houses, machinery spaces, air handling plants, tank rooms and other plant or apparatus, including the location, identity, size and rating of each apparatus. The information with respect to the size and rating can be presented in schedule form;

b) isometric or diagrammatic views of boiler houses, plant rooms, tank rooms and similar machinery, including valve identification charts. It is useful to frame and mount a copy of such drawings on the wall of the appropriate room; and

c) comprehensive diagrams that show power wiring and control wiring and/or pneumatic or other control piping including size, type or conductor or piping used and identifying the terminal points of each.

26.5.5 *Electrical Records*

Documentation should record the following including locations, as installed:

a) main and submain cables, showing origin, route, termination, size and type of each cable; cables providing supplies to specialist equipment, for example, computers, should be identified separately; and

b) lighting conduits and final subcircuit cables, showing origin, route, termination and size of each, together with the number and size of cables within each conduit. The drawings should indicate for each conduit or cable, whether it is run on the surface or concealed, for example, in a wall chase, in a floor screed, cast *in-situ*, above a false ceiling etc.

These drawings should also indicate the locations of lighting fittings, distribution boards, switches, draw-in-boxes and point boxes, and should indicate circuitry:

a) location and purpose of each emergency lighting fitting including an indication of the circuit to which it is connected;

b) single and three phase power conduits and final subcircuit cables showing locations of power distribution boards, motors, isolators,

starters, remote control units, socket outlets and other associated equipment;

c) other miscellaneous equipment, conduits and cables;

d) lightening conductor, air terminals, conductors, earth electrodes and test clamps;

e) location of earth tapes, earth electrodes and test points other than those in (f); and

f) cables providing earth circuits for specialist equipment, for example computers, should be identified separately.

Documentation should also include, when applicable.

a) distribution diagrams or schedules to show size, type and length (to within 1 m) of each main and submain cable, together with the measured earth continuity resistance of each;

b) schedule of lighting fittings installed stating location, manufacturer and type or catalogue number together with the type or manufacturer's reference, voltage and wattage of the lamp installed;

c) schedule of escape and emergency lighting fittings installed stating location, manufacturer, type or catalogue number together with the type or manufacturer's reference, voltage and wattage of the lamp installed. For battery systems the position of the battery, its ampere hour rating and battery system rated endurance in hours should be stated;

d) records of smoke detectors, sprinklers, fire precautions;

e) incoming supply details; the type of system, voltage, phases, frequency, rated current and short circuit level, with the details of the supply protection and time of operation as appropriate;

g) main switchgear details; for purpose made equipment this should include a set of manufacturers' drawings and the site layout;

h) transformer, capacitor and power plant details; the leading details should be given, for example, for transformers the V.A rating, voltages and type of cooling; and

j) Completion certificate, according to the *Indian Electricity Act*.

26.6 Inspections

26.6.1 *General*

Regular inspections are actual part of the procedures for the maintenance of buildings. They are needed for a variety of purposes and each purpose requires a different approach if it is to be handled with maximum economy and efficiency. A more detailed inspection covering all parts of a building is needed to determine what work should be included in cyclic and planned maintenance programme.

26.6.2 *Frequency of Inspection*

Inspection should be carried out at the following frequencies:

a) *Routine* — Continuous regular observations should be undertaken by the building user as part of the occupancy of building. Feed back resulting from this type of observation should be encouraged.

b) *General* — Visual inspections of main elements should be made annually under the supervision of suitably qualified personnel at appropriate times.

c) *Detailed* — The frequency of full inspection of the building fabric by suitably qualified personnel should not normally exceed a 5 year period.

26.6.2.1 *Inspection schedule*

The preparation of a specific schedule should be encouraged. Once prepared, it can be used for subsequent inspections.

26.6.3 *Inspection of Engineering Services*

Engineering services generally have a shorter life expectancy than building fabric and because of their dynamic function should be subjected to more frequent inspections and maintenance.

26.6.3.1 Inspection of services should be carried out for three purposes as follows:

a) to check if maintenance work is required,

b) to check if maintenance work is being adequately carried out, and

c) for safety reasons to comply with statutory requirements and if required, with recommendations of other relevant organizations.

26.6.3.2 The frequency of inspections for purpose (a) will depend upon types of plant and system manufacturer's recommendations and subjective judgement. Frequencies for purpose (b) should be carried out on an annual basis.

26.6.3.3 *Method of inspection*

The limited life of building services means it is important to record their residual life so that their replacement can be budgeted for, and inspection methods should be arranged accordingly.

A check list of items of plant to be inspected should be considered. Detailed specifications of how inspections should be carried out are necessary because a simple visual inspection is unlikely to show whether plant is operating correctly and efficiently.

Inspections frequently necessitate the use of appropriate instruments by competent persons. An example of this is the inspections carried out to check compliance with statutory requirements.

When instruments are used it is important that adequate training is provided in the use of the instruments and the interpretation of the results.

26.6.4 Records of all inspections should be kept.

26.6.5 *Inspection Report*

Inspection report may be prepared in the format as given in Annex D.

26.7 Maintenance of Electrical Appliances

26.7.1 *Planning of Maintenance Work*

26.7.1.1 If the authorized person has complete knowledge of the electrical appliances to be worked upon, then safety will be more assured. If the person attending to the job is not technically competent to handle the job then more careful planning is required before hand.

26.7.1.2 Repetitive nature of jobs involve little or no pre-planning whereas infrequent nature of jobs may need careful planning even if the person attending the job is technically competent.

26.7.1.3 Planned routine maintenance will facilitate continued safe and acceptable operation of an electrical system with a minimum risk of breakdown and consequent interruption of supply.

26.7.1.4 As far as the electrical equipments/ installations are concerned, it is not possible to laydown precise recommendations for the interval between the maintenance required. The recommendation for frequency of maintenance in this regard from the manufacturer is more relevant. The manufacturer should be requested to specify minimum maintenance frequency under specified conditions. These intervals depend greatly upon the design of the equipment, the duty that it is called on to perform and the environment in which it is situated.

26.7.2 Following two types of maintenance are envisaged.

26.7.2.1 *Routine maintenance*

Routine maintenance of the electrical equipments goes alongwith the regular inspections of the equipments. Inspections shall reveal the undue damage and excessive wear to the various components. Examination of the equipment shall reveal any need for conditioning of the contact system, lubrication and adjustment of the mechanisms.

26.7.2.2 *Post fault maintenance*

When there is a breakdown in the system and certain parts are identified for the replacement and then the maintenance/repair of the defective part away from the operating environment is covered under post fault maintenance.

26.7.3 *Guidelines for the Maintenance of Electrical Appliances*

26.7.3.1 Uninterrupted and hazard free functioning of the electrical installations are the basic parameters of maintenance. The equipment should be restored to correct working conditions. Special attention should be paid to the items and settings that might have been disturbed during the operational phase. Loose and extraneous equipment or wiring give rise to potential safety hazards. All covers and locking arrangements should be properly checked and secured to achieve original degree of protection.

26.7.3.2 Guidelines to be followed for the maintenance of electrical equipments to ensure their smooth functioning are given in Annex E.

26.8 Operating and Maintenance Manuals

The engineering services within buildings frequently are dynamic, involving complex systems of integrated plant items. Operation of such plant can require detailed knowledge and direction. Maintenance can also require extensive information to be available. It is, therefore, important to have suitable operating and maintenance manuals to provide the necessary guidance. These should be included as part of the contractual requirements for new installations and should ideally be prepared as reference documents for existing installations where no such information exists.

26.9 For details on labour management concerning building maintenance, reference shall be made to good practice [7(32)].

26.10 For details on financial management concerning building maintenance, reference shall be made to good practice [7(33)].

27 PREVENTION OF CRACKS

27.1 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.

27.2 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.

27.3 For complete details on causes and prevention of non-structural cracks, reference shall be made to good practice SP 25 : 1984 'Handbook on causes and prevention of cracks in buildings'.

28 REPAIRS AND SEISMIC STRENGTHENING OF BUILDINGS

28.1 General Principles and Concepts

28.1.1 *Non-structural/Architectural Repairs*

28.1.1.1 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 are carried out. Care should be taken about the connection details of architectural components to the main structural components to ensure their stability.

28.1.1.2 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) Re-building non-structural walls, smoke chimneys, parapet walls, etc;
f) Re-plastering of walls as required;
g) Rearranging disturbed roofing tiles;
h) Relaying cracked flooring at ground level; and
j) 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 the similar shock because original energy absorption capacity of the building would have been reduced.

28.1.2 *Structural Repairs*

28.1.2.1 Prior to taking up of the structural repairs and 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 amendable 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 amendable 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.

28.1.2.2 After the assessment of the damage of individual structural elements, appropriate repair methods are to be carried out componentwise depending upon the extent of damage. The repair may consist of the following:

a) Removal of portions of cracked masonry walls and piers and rebuilding them in richer mortar. Use of non-shrinking mortar will be preferable.
b) Addition of reinforcing mesh on both faces of the cracked wall, holding it to the wall

through spikes or bolts and then covering it, suitably, with cement mortar or micro-concrete.

c) Injecting cement or epoxy like material which is strong in tension, into he cracks in walls.

d) The cracked reinforced cement elements may be repaired by epoxy grouting and could be strengthened by epoxy or polymer mortar application like shotcreting, jecketting, etc.

28.1.3 *Seismic Strengthening*

The main purpose of the seismic strengthening is to upgrade the seismic resistance of a damaged building while repairing so that it becomes safer under future earthquake occurrences. This work may involve some of the following actions:

a) Increasing the lateral strength in one or both directions by increasing column and wall areas or the number of walls and columns.

b) Giving unity to the structure, by providing a proper connection between its resisting elements, in such a way that inertia forces generated by the vibration of the building can be transmitted to the members that have the ability to resist them. Typical important aspects are the connections between roofs or floors and walls, between intersecting walls and between walls and foundations.

c) Eliminating features that are sources of weakness or that produce concentration of stresses in some members. Asymmetrical plan distribution of resisting members, abrupt changes of stiffness from one floor to the other, concentration of large masses and large openings in walls without a proper peripheral reinforcement are examples of defects of this kind.

d) Avoiding the possibility of brittle modes of failure by proper reinforcement and connection of resisting members.

28.1.4 *Seismic Retrofitting*

Many existing buildings do not meet the seismic strength requirements of present earthquake codes due to original structural inadequacies and material degradation due to time or alterations carried out during use over the years. Their earthquake resistance can be upgraded to the level of the present day codes by appropriate seismic retrofitting techniques, such as mentioned in **28.1.3**.

28.1.5 *Strengthening or Retrofitting Versus Reconstruction*

28.1.5.1 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. 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.

28.1.5.2 Cost-wise the building construction including the seismic code provisions in the first instance, works out 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.

28.2 For detailed guidelines for repairs and seismic strengthening of buildings, reference shall be made to good practice [7(34)].

28.3 For detailed guidelines for improving earthquake resistance of low strength masonry buildings, reference shall be made to good practice [7(35)].

28.4 For detailed guidelines for improving earthquake resistance of earthen buildings, reference shall be made to good practice [7(36)].

SECTION 5 SAFETY IN DEMOLITION OF BUILDINGS

29 GENERAL

29.1 This Section lays down the safety requirements for carrying out demolition/dismantling work.

29.2 Planning

Before beginning the actual work of demolition a careful study shall be made of the structure which is to be pulled down and also of all its surroundings. This shall, in particular, include study of the manner in which the various parts of the building to be demolished are supported and how far the stage by stage demolition

will affect the safety of the adjoining structure. A definite plan of procedure for the demolition work, depending upon the manner in which the loads of the various structural parts are supported, shall be prepared and approved by the engineer-in-charge and this shall be followed as closely as possible, in actual execution of the demolition work. Before the commencement of each stage of demolition, the foreman shall brief the workmen in detail regarding the safety aspects to be kept in view.

It should be ensured that the demolition operations do not, act any stage, endanger the safety of the adjoining buildings. Moreover, the nuisance effect of the demolishing work on the use of the adjacent buildings should be kept to the minimum.

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.

30 PRECAUTIONS PRIOR TO DEMOLITION

30.1 On every demolition job, danger signs shall be conspicuously posted all around the structure and all doors and openings giving access to the structure shall be kept barricaded or manned except during the actual passage of workmen or equipment. However, provisions shall be made for at least two independent exits for escape of workmen during any emergency.

30.2 During nights, red lights shall be placed on or about all the barricades.

30.3 Where in any work of demolition it is imperative, because of danger existing, to ensure that no unauthorized person shall enter the site of demolition outside hours; a watchman should be employed. In addition to watching the site he shall also be responsible for maintaining all notices, lights and barricades.

30.4 All the necessary safety appliances shall be issued to the workers and their use explained. It shall be ensured that the workers are using all the safety appliances while at work.

30.5 The power on all electrical service lines shall be shut off and all such lines cut or disconnected at or outside the property line, before the demolition work is started. Prior to cutting of such lines, the necessary approval shall be obtained from the electrical authorities concerned. The only exception will be any power lines required for demolition work itself.

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

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

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

30.9 Protection of the Public

30.9.1 Safety distances to ensure safety of the public shall be clearly marked and prominently sign posted. Every sidewalk or road adjacent to the work shall be closed or protected. All main roads, which are open to the shall be kept open to the public clear and unobstructed at all times. Diversions for pedestrians shall be constructed, where necessary for safety.

30.9.2 If the structure to be demolished is more than two storeyed or 7.5 m high, measured from the side walk or street which can not be closed or safely diverted, and the horizontal distance from the inside of the sidewalk to the structure is 4.5 m or less, a substantial sidewalk shed shall be constructed over the entire length of the sidewalk adjacent to the structure, of sufficient width with a view to accommodating the pedestrian traffic without causing congestion. The side walk shed shall be lighted sufficiently to ensure safety at all times. For detailed information reference may be made to good practice [7(37)].

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

Except where the roof of a sidewalk shed solidly abuts the structure, the face of the sidewalk shed towards the building shall be completely closed by providing sheating/planking to prevent falling material from penetrating into the shed.

The roof of sidewalk sheds shall be capable of sustaining a load of 73 N/mm^2. Only in exceptional cases, say due to lack of other space, the storing of material on a sidewalk shed may be permitted in which case the shed shall be designed for a load of 146 N/mm^2. Roof of sidewalk shed shall be designed taking into account the impact of the falling debris. By frequent removal of loads it shall be ensured that the maximum load, at any time, on the roof of work shed is not more than 6 000 N/mm^2. The height of sidewalk shed shall be such as to give a minimum clearance of 2.4 m.

Sidewalk shed opening, for loading purposes, shall be kept closed at all time except during actual loading operations.

The deck flooring of the sidewalk shed shall consist of plank of not less than 50 mm in thickness closely laid and deck made watertight. All members of the shed shall be adequately bracked and connected to resist displacement of members or distortion of framework.

30.9.3 When the horizontal distance from the inside of the sidewalk to the structure is more than 4.5 m and less than 7.5 m, a sidewalk shed or fence a substantial railing shall be constructed on the inside of the sidewalk or roadway along the entire length of the demolition side of the property with movable bars as may be necessary for the proper prosecution of the work.

31 PRECAUTIONS DURING DEMOLITION

31.1 Prior to commencement of work, all material of fragile nature like glass shall be removed.

31.2 All openings shall be boarded up.

31.3 Dust shall be controlled by suitable means to prevent harm to workmen.

31.4 Stacking of materials or debris shall be within safe limits of the structural member. Additional supports, where necessary, shall be given.

31.5 Adequate natural or artificial lighting and ventilation shall be provided for the workmen.

32 SEQUENCE OF DEMOLITION OPERATIONS

32.1 The demolition work shall be proceeded with in such a way that:

a) it causes the least damage and nuisance to the adjoining building and the members of the public, and
b) it satisfies all safety requirements to avoid any accidents.

32.2 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.

32.3 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.

32.4 All well openings which extend down to floor level shall be barricaded to a height of not less than 1 m above the floor level. This provision shall not apply to the ground level floor.

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

32.6 The demolition shall always proceed systematically storey by storey. In the descending order. All work in the upper floor shall be completed and approved by the engineer-in-charge prior to disturbance to any supporting member on the lower floor. Demolition of the structure in sections may be permitted in exceptional cases if proper precautions are ensured to prevent injuries to persons and damage to property.

33 WALLS

33.1 While walls of sections of masonry are being demolished, it shall be ensured that they are not allowed to fall as single mass upon the floors of the building that are being demolished so as to exceed the safe carrying capacity of the floors. Overloading of floors shall be prevented by removing the accumulating debris through chutes or by other means immediately. The floor shall be inspected by the engineer-in-charge before undertaking demolition work and if the same is found to be incapable to carry the load of the debris, necessary additional precautions shall be taken so as to prevent any possible unexpected collapse of the floor.

33.2 Walls shall be removed part by part. Stages shall be provided for the men to work on if the walls are less than one and a half brick thick and dangerous to work by standing over them.

33.3 Adequate lateral bracing shall be provided for walls which are unsound. For detailed information reference may be made to good practice [7(37)].

34 FLOORING

34.1 Prior to removal of masonry or concrete floor adequate support centering shall be provided.

34.2 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.

34.3 Planks of sufficient strength shall be provided to give workmen firm support to guard against any unexpected floor collapse.

34.4 When floors are being removed no person shall be allowed to work in an area directly underneath and access to such area shall be barricaded.

35 DEMOLITION OF STEEL STRUCTURES

35.1 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.

35.2 Overloading of equipment shall not be allowed.

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

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

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

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

36 CATCH PLATFORM

36.1 In demolition of exterior walls of multistorey structures, catch platform of sufficient strength to prevent injuries to workers below and public shall be provided, when the external walls are more than 20 m in height.

36.2 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.

36.3 Catch platform shall be capable of sustaining a live load of not less than 6 100 N/m^2.

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

37 STAIRS, PASSAGEWAYS AND LADDERS

37.1 Stairs with railings, passageways and ladders shall be left in place as long as possible and maintained in a safe condition.

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

38 MECHANICAL DEMOLITION

When demolition is to be performed by mechanical devices, such as weight ball and power shovels, the following additional precautions may be observed:

a) The area shall be barricaded for a minimum distance of 1½ times the height of the wall,

b) While the mechanical device is in operation, no workmen shall be allowed to enter the building being demolished,

c) The device shall be so located as to avoid falling debris, and

d) The mechanical device when being used shall not cause any damage to adjacent structure, power line, etc.

39 DEMOLITION OF CERTAIN SPECIAL TYPES AND ELEMENTS OF STRUCTURES

39.1 Roof Trusses

If a building has a pitched roof, the structure should be removed to wall plate level by hand methods. Sufficient purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively.

39.1.1 Temporary bracking 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.

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

39.1.3 Adequate hoisting gears suitable for the loads shall be provided. If during demolition any thing is to be put on the floor below the level of the truss, it shall be ensured that the floor is capable of taking the load.

39.2 Heavy Floor Beams

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

39.3 Jack Arches

Where tie rods are present between main supporting beams, these should not be cut until after the arch or series of arches in the floor have been removed. The floor should be demolished in strips parallel to the span of the arch rings (at right angles to the main floor beams).

39.4 Brick Arches

Expert advice should be obtained and, at all stages of the demolition, the closet supervision should be given by persons fully experienced and conversant in the type of work to ensure that the structure is stable at all times.

However, the following points may be kept in view.

39.4.1 On no account should the restraining influence of the abutments be removed before the dead load of the spandrel fill and the arch rings are removed.

39.4.2 A single span arch can be demolished by hand by cutting narrow segments progressively from each springing parallel to the span of the arch, until the width of the arch has been reduced to a minimum which can then be collapsed.

39.4.3 Where deliberate collapse is feasible, the crown may be broken by the demolition ball method working progressively from edges to the centre.

39.4.4 Collapse of the structure can be effected in one action by the use of explosives. Charges should be inserted into bore holes drilled in both arch and abutments.

39.4.5 In multi-span arches, before individual arches are removed, lateral restraint should be provided at the springing level. Demolition may then proceed as for single span; where explosives are used it is preferable to ensure the collapse of the whole structure in one operation to obviate the chance of leaving unstable portion standing.

39.5 Cantilever (Not Part of a Framed Structure)

Canopies, cornices, staircases and balconies should be demolished or supported before tailing down load is removed.

39.6 *In-situ* Reinforced Concrete

Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement should be ascertained.

Demolition should be commenced by removing partitions and external non-load bearing cladding.

39.6.1 *Reinforced Concrete Beams*

A supporting rope should be attached to the beam. Then the concrete should be removed from both ends by pneumatic drill and the reinforcement exposed. The reinforcement should then be cut in such a way as to allow the beam to be lowered under control to the floor.

39.6.2 *Reinforced Concrete Columns*

The reinforcement should be exposed at the base after restraining wire guy ropes have been placed round the member at the top. The reinforcement should then be out in such a way as to allow it to be pulled down to the floor under control.

39.6.3 *Reinforced Concrete Walls*

These should be cut into strips and demolished as for columns.

39.6.4 *Suspended Floors and Roofs*

The slab should be cut into strips parallel to the main reinforcement and demolished strip by strip. Where ribbed construction has been used, the principle of design and method of construction should be determined before demolition is commenced. Care should be taken not to cut the ribs inadvertently.

39.7 Precast Reinforced Concrete

Due precautions shall be taken to avoid toppling over of prefabricated units or any other part of the structure and whenever necessary temporary supports shall be provided.

39.8 Prestressed Reinforced Concrete

Before commencing of the demolition work, advice of an engineering expert in such demolition shall be obtained and followed.

40 LOWERING, REMOVAL AND DISPOSAL OF MATERIALS

40.1 Dismantled materials may be thrown to the ground only after taking adequate precautions. The material shall preferably be dumped inside the building. Normally such materials shall be lowered to the ground or to the top of the sidewalk shed where provided by means of ropes or suitable tackles.

40.2 Through Chutes

40.2.1 Wooden or metal chutes may be provided from removal of materials. The chutes shall preferably be provided at the centre of the building for efficient disposal of debris.

40.2.2 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.

40.2.3 To prevent the descending material attaining a dangerous speed, chute shall not extend in an unbroken line for more than two storeys. A gate or stop shall be provided with suitable means for closing at the bottom of each chute to stop the flow of materials.

40.2.4 Any opening into which workmen dump debris at the top of chute shall be guarded by a substantial guard rail extending at least 1 m above the level of the floor or other surface on which men stand to dump the materials into the chute.

40.2.5 A toe board or bumper, not less than 50 mm thick and 150 mm high shall be provided at each chute openings, if the material is dumped from the wheel barrows. Any space between the chute and the edge of the opening in the floor through which it passes shall be solidly planked over.

40.3 Through Holes in the Floors

40.3.1 Debris may also be dropped through holes in the floor without the use of chutes. In such a case the total area of the hole cut in any intermediate floor, one which lies between floor that is being demolished and the storage floor shall not exceed 25 percent of such floor area. It shall be ensured that the storage floor is of adequate strength to withstand the impact of the falling material.

40.3.2 All intermediate floor openings for passage of

materials shall be completely enclosed with barricades or guard rails not less than 1 m high and at a distance of not less than 1 m from the edge of general opening. No barricades or guard rails shall be removed until the storey immediately above has been demolished down to the floor line and all debris cleared from the floor.

40.3.3 When the cutting of a hole in an intermediate floor between the storage floor and the floor which is being demolished makes the intermediate floor or any portion of it unsafe, then such intermediate floor shall be properly shored. It shall also be ensured that the supporting walls are not kept without adequate lateral restraints.

40.4 Removal of Materials

40.4.1 As demolition work proceeds, the released serviceable materials of different types shall be separated from the unserviceable lot (hereinafter called '*MALBA*') at suitable time intervals and properly stocked clear of the spots where demolition work is being done.

40.4.2 The *MALBA* 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 *MALBA* heap shall be limited to ensure its toppling over or otherwise endangering the safety of workmen or passersby.

40.4.3 The *MALBA* shall be removed from the demolition site to a location as required by the local civil authority. Depending on the space available at the demolition site, this operation of conveying *MALBA* to its final disposal location may have to be carried out a number of times during the demolition work. In any case, the demolition work shall not be considered as completed and the area declared fit for further occupation till all the *MALBA* has been carried to its final disposal location and the demolition areas tidied up.

40.4.4 Materials which are likely to cause dust nuisance or undue environmental pollution in any other way, shall be removed from the site at the earliest and till then they shall be suitable covered. Such materials shall be covered during transportation also.

40.4.5

a) Glass and steel should be dumped or buried separately to prevent injury.

b) Workman should be provided with suitable protective gears for personal safety during works, lie safety helmets, boots, hand gloves, goggles, special attire, etc.

c) The work of removal of debris should be carried out during day. In case of poor visibility artificial light may be provided.

d) The debris should first be removed from top. Early removal from bottom or sides of dump may cause collapse of debris, causing injuries.

41 MISCELLANEOUS

41.1 No demolition work should be carried out during night as far as possible, especially when the structure to be demolished is in an inhabited area. If such night work has to be done, additional precautions by way of additional red warning signals, working lights and watchmen, shall be provided to avoid any injury to workmen and public. Demolition work shall not be carried out during storm and heavy rain.

41.2 Warning devices shall be installed in the area to warn the workers in case of any danger.

41.3 Safety devices like industrial safety helmets conforming to the accepted standards [7(9)] and goggles made of celluloid lens, shall be issued to the workmen. Foreman-in-charge of the work areas shall ensure that all the workmen are wearing the safety devices before commencing any work.

41.4 Construction sheds and tool boxes shall be so located as to protect workers from injuries from the falling debris.

41.5 Where there is a likelihood of injuries to hands of workmen when demolishing RCC, steel structures, etc, gloves of suitable materials shall be worn by workmen.

41.6 Sufficient protection by way of both overhead cover and screens shall be provided to prevent injuries to the workmen and the public.

41.7 Safety belts or ropes shall be used by workmen when working at higher levels.

41.8 Grading of Plot

When a building has been demolished and no building operation has been projected or approved, the vacant plot shall be filled, graded and maintained in conformity to the established street grades at curb level. The plot shall be maintained free from the accumulation of rubbish and all other unsafe and hazardous conditions which endangers the life or health of the public; and provisions shall be made to prevent the accumulation of water or damage to any foundations on the premises or the adjoining property.

42 FIRST-AID

42.1 A copy of all pertinent regulations and notices concerning accidents, injury and first-aid shall be prominently exhibited at the work site.

42.2 Depending on the scope and nature of the work,

a person, qualified in first-aid shall be available at work site to render and direct first-aid to casualties. He shall maintain a list of individuals qualified to serve in first-aid work. Enough first-aid kit, including a stretcher and cot with accessories shall be provided at site. A telephone may be provided to first-aid assistant with telephone numbers of the hospitals prominently displayed.

Complete reports of all accidents and action taken thereon shall be forwarded to the competent authorities.

ANNEX A

(*Clause* 2.1.2)

PROGRAMME EVALUATION AND REVIEW TECHNIQUE, AND CRITICAL PATH METHOD

A-0 INTRODUCTION

A-0.1 Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM) are modern management tools or devices, which have made it possible to achieve considerable savings in cost and time of construction. They can be used with advantage for demolition, constructional safety and fire protection measures, by including them in the list of activities (also called events) along-side with other 'events' of the project.

A-0.2 Advance Planning

A-0.2.1 PERT and CPM enable us to achieve judicious employment and utilization of resources, such as labour, materials, and equipment by pre-determining the various stages, listing out the various activities and drawing out 'Arrow Network Diagram'.

A-0.3 Synchronization of Sub-Projects

A-0.3.1 Another extremely important advantage of CPM is that various factors influencing completion of a project can be scientifically planned to be coordinated such that the completion of various sub-projects and services, such as furniture, sewage, electricity and water supply synchronises.

A-1 PREPARATION OF CPM CHART (LISTING OUT THE ACTIVITIES)

A-1.1 The most important step in preparation of CPM network is to list out the activities involved to the minutest details. For example, a few activities in case of a building project are given below:

a) Planning and designing of building by architect, engineer and approval of plans by the Authority.
b) Making the land available.
c) Outlining detailed specifications.
d) Procurement of materials, such as sand, cement, stone and timber; and plants, such as concrete mixer, vibrators, water pump for curing.
e) Soil explorations and trial pits.
f) Excavation in foundations, including demolition, if needed.
g)[1] Construction safety aspects specially in case of pile foundations.
h)[1] Blasting if required (for deep foundations).
j)[1] Fire protection measures.

A-1.2 Time Needed for Each Activity

An assessment is to be made to find out the time needed for each activity and then to list out those activities, which can be executed concurrently (or simultaneously) with each other. For example, while designing of the building is in hand, correspondence for land purchase can also go on side by side; or while work in foundations is in progress, order for 'joinery' can be placed.

A-1.3 Critical Activity

It should then be seen as to which of the activities are critical, that is which items are such that a single day's delay will mean overall delay on the project. Contrary to this, it will be seen from CPM Network that certain activities can be delayed to a certain extent without delaying the completion of the project. This is a very useful and valuable information for the 'Project Manager'. That is where resources scheduling becomes easier and economical and a time saver. It eliminates chances of idle labour and higher expenses which are results of haphazard planning.

A-2 UPDATING

A-2.1 In implementing the CPM, there could be gaps between the planned CPM and actual progress

[1] These can be further sub-divided and number of activities increased.

or position on ground. This should be checked periodically-weekly, fortnightly or monthly depending on nature and size of project.

A-3 GENERAL

A-3.1 In case of projects being executed by contractors for the owners, or departments, it is recommended that it should be an essential condition of the contract to submit a CPM Chart along with the quoted tenders. This will ensure that the construction work will be according to a systematic, engineer-like and well-knit plan of execution.

ANNEX B

(*Clause* 4.1)

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, prefabricated 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			✓		✓	✓				✓

ANNEX B — *Continued*

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
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 C

(*Clause* 26.3.2.2.2)

COMMON CAUSES FOR MAINTENANCE PROBLEMS

C-0 MAJOR CAUSES FOR MAINTENANCE PROBLEMS

C-1 FLOORS

a) Poor quality of construction which includes quality of construction material and workmanship.

b) Improper slopes, mainly in kitchen, bathrooms/ toilets etc.

c) Lack of rounding at junctions of walls with floors.

d) Lack of dampproof course treatment in walls and particularly in sunken floors.

e) Poor design of building.

C-2 ROOFS

a) Inadequate roof slopes.

b) Inferior quality of construction.

c) Cracks on roof surfaces.

d) Inadequate provision of rain water spouts.

e) Blockages in gratings/rain water pipes.

f) Worn out felts.

g) Bubbling up of tarfelt and separation of joints.

h) Leakage from the openings provided on the roof.

C-3 PLUMBING

a) Inadequate slopes in soil/waste pipes.

b) Improper lead joints.

c) Joints in walls.

d) Improper junctions of stacks.

e) Inadequate cleaning eyes at junctions.

f) Inadequate slopes in sewage pipes.

g) Throwing of solid wastes in WC's.

h) Lack of periodical checking and cleaning.

j) Lack of motivation/education to users for proper use.

k) Overflow from service tanks.

m) Inferior quality of fittings and fixtures.

n) Inadequate design.

C-4 DRAINAGE

a) Improper surface dressing around buildings and improper upkeep of surroundings.
b) Growth of wild grass and vegetation.
c) Inadequate drainage system around the building.
d) Inadequate slope of the drains or drainage pipes.
e) Inadequate number of inspection chambers.
f) Theft of manhole covers etc.
g) Throwing of solid waste in the open surface drains.

C-5 ELECTRICAL

a) Loose connections.
b) Improper earthing and earth connections.
c) Damages to wires, cables and other installations.
d) Under rated cables/wires and other installations.

ANNEX D

(*Clause* 26.6.5)

FORMAT FOR INSPECTION REPORT

Date : .....
Building/Block : .....
.....

		Condition		
		Sound	Suspect	Defective
FLOORS & STAIRCASES				
Ground Floor				
Finish				
Skirting				
Structure				
Damp-proofing				
Ceiling				
Under floors, spaces, (Suspended floors)				
Termites/insects				
Upper Floors				
Finish				
Structure				
Ceiling				
Suspended ceiling				
Stair cases				
Structure				
Treads				
Finishes				
Balustrade				
Soffits				
Finish				
ROOFING				
Flat/Pitched				
Finish				
Insulation				
Structure				

ANNEX D — *Continued*

		Condition		
		Sound	Suspect	Defective
Roof lights/glazing				
Parapets				
Cutters				
Rain Water Pipes				
Mud *Phuska*				
Roof interiors (Pitched)				
Growth of vegetation				
SANITARY INSTALLATIONS				
Plumbing				
Fittings/Pipings, WC's				
Taps				
Sinks				
Basins				
Urinals				
Cisterns				
Geysers				
Sewage Disposal				
Soil pipes				
Manholes				
Sewerlines				
Drainage				
Gully chambers				
Sewers				
Surface drains				
Inspection chambers				
Structural movement				
Failure of material				
Design or construction defects				
Overhead Tanks/Underground				
Sumps/Terrace Tanks				
Septic Tanks				
Remarks				

ANNEX E

(*Clause* 26.7.3.2)

GUIDELINES FOR MAINTENANCE OF ELECTRICAL EQUIPMENTS

E-1 In case of electrical appliances, manufacturer's instructions for the usage and maintenance of the equipment should be strictly followed.

E-2 The detailed/working drawings of all the components of electrical installations should always be available with the maintenance unit. Following records should be available.

a) Manufacturer's name

b) Nameplate of the equipment and its sailent features such as capacity, rating etc.

c) Manufacturer's recommendations regarding availability/usage of spare parts.

d) Manufacturer's recommendations for periodical maintenance and post fault maintenance.

e) Details of the maintenance operations performed in the past.

E-3 Care should be taken while selecting replacement parts. The spare parts should be correct and suitable, preferably as recommended by the manufacturer of the installation. During the placement of order for the supply of spare parts, nameplate particulars and serial number should be quoted.

E-4 The space where the equipment is kept should be clean and properly ventilated. Equipment should not be disturbed needlessly. Before cleaning, the equipment should be made dead. For internal cleaning a section cleaner should be used.

E-5 Covers and doors should not be left open unnecessarily during maintenance. Afterwards they should be promptly and correctly closed and locked.

E-6 Before removing the covers and connections, all covers and cable terminations should be marked to ensure correct replacements. Disturbed connections and temporary connections should be marked to facilitate re-connection. Temporary connections and markings should be removed before the installation is put to use.

E-7 Those connections which have not been disturbed should also be checked for soundness and overheating.

E-8 All insulations should be regularly checked. Solid insulations should be checked for cracks and other defects. Fibrous and organic insulations should be checked for sign of blistering, delamination and mechanical damage. For insulating oils the interval between tests should be carried out as per the recommendations of the manufacturer and keeping the adverse environmental conditions in mind.

E-9 It should be ensured that the earthing connections are sound and all contact screws are tight.

E-10 During the examination of interlocks it is necessary to take precautions to prevent danger to plant or persons in the event of malfunction or inadvertent operation. A person responsible for checking and maintaining any interlock system should have thorough knowledge of the extent, nature and function of the interlock.

E-11 If the equipment is ventilated then it should be ensured that the airflow is smooth and not restricted. If filters are provided, they should be cleaned or replaced as necessary.

E-12 The standby system for tripping and closing supplies should always be kept in good order. Indicators and alarms should be maintained in time with the manufacturer's instructions.

E-13 Tools, spares and instruments should be stored near to the installation. These should be regularly checked against an inventory.

E-14 Before the start of maintenance of the circuit switches it should be ensured that all incoming and outgoing main auxiliary circuits are dead and remain so during the maintenance. Over heating of the circuit switches is the root cause for faults. Overheating may be caused by inadequate ventilation, overloading, loose connection, insufficient contact force and malalignment.

E-15 Some circuit breakers are not intended to be maintained, such as miniature circuit breakers (MCBs). Such items should not be dismantled for maintenance. These should be renewed periodically.

E-16 For the maintenance of fuses periodical inspection should be done for correct rating, security, overheating and correct location/orientation. Element of renewable fuses should be renewed when the deterioration is apparent. The availability and correct replacement of fuse links should be ensured.

E-17 If a fuse link of certain rating has failed and is replaced, then all fuse-links of same rating apparently subjected to the fault should be destroyed and replaced by new fuse links.

E-18 In order to be reasonably sure that circuit breaker is capable of operation when required, these should be tripped and reclosed at regular intervals. Tripping should be proved manually and where possible electrically via the protective relay contacts. The leakage of oil, sign of corrosion, and any unusual smell which may indicate over-heating should be detected through inspections.

E-19 Timing devices are mostly designed for specialist maintenance. These should not be dismantled for maintenance or overhaul purposes unless specifically recommended by the manufacturers'. Actual timing periods should be verified with set values and application requirements.

E-20 In case of cable boxes and terminations, security of mounting and earthing should be examined. Exposed tails should be inspected for good conditions of insulation and freedom from moisture.

E-21 Battery cells should be inspected for shedding of active material, sedimentation and buckling of plates. Level of electrolyte should be regularly checked and the level should be corrected with distilled water.

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 as a guide in conformance with the requirements of the referred clauses in the Code.

IS No.	*Title*
(1) 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 : 1986	Code of practice for design and construction of foundations in soils: General requirements (*third revision*)
2911	Code of practice for design and construction of pile foundations
(Part 1/Sec 1) : 1979	Concrete piles, Section 1 Driven cast *in-situ* concrete piles (*first revision*)
(Part 1/Sec 2) : 1979	Concrete piles, Section 2 Board cast *in-situ* piles (*first revision*)
(Part 1/Sec 3) : 1979	Concrete piles, Section 3 Driven precast concrete piles (*first revision*)
(Part 1/Sec 4) : 1984	Concrete piles, Section 4 Bored precast concrete piles (*first revision*)
(Part 2) : 1980	Timber piles (*first revision*)
(Part 3) : 1980	Under-reamed piles (*first revision*)
(Part 4) : 1985	Load test on piles (*first 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
13094 : 1992	Guidelines for selection of ground improvement techniques for foundation in weak soils
15284 (Part 1) : 2003	Design and construction for ground improvement: Part 1 Stone columns
b) *Masonry*	
1597	Code of practice for construction of stone masonry
(Part 1) : 1992	Rubble stone masonry (*first revision*)
(Part 2) : 1992	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 : 1963	Code of practice for construction of hollow concrete block masonry

IS No.	*Title*
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 : 1984	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
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	Code of practice for concrete structures for the storage of liquids
(Part 1) : 1965	General requirements
(Part 2) : 1965	Reinforced concrete structures
(Part 3) : 1967	Prestressed concrete structures
3558 : 1983	Code of practice for use of immersion vibrators for consolidating concrete (*first 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 : 1982	Recommended guidelines for concrete mix design
10359 : 1982	Code of practice for manufacture and use of lime pozzolana concrete blocks for paving

IS No.	*Title*
14687 : 1999	Guidelines for falsework for concrete structures
e) *Steel*	
800 : 1984	Code of practice for general steel construction (*second 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 : 1978	Code of practice for laying bitumen mastic flooring (*second 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 : 1972	Code of practice for laying and finishing of cement concrete flooring tiles (*first 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 (Part 1) : 1968	Code of practice for laying and fixing of sloped roof coverings: Part 1 Slating
5318 : 1969	Code of practice for laying of flexible PVC sheet and tile flooring

IS No.	*Title*
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*)
IS 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 : 1984	Code of practice for laying *in-situ* terrazzo floor finish (*first 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	Pre-treatment
(Part 2) : 1968	Painting
3036 : 1992	Code of practice for laying lime concrete for a water-proofed roof finish (*second revision*)
3067 : 1988	Code of practice for general design details and preparatory work for damp-proofing and waterproofing of buildings (*first revision*)

IS No.	*Title*
3140 : 1965	Code of practice for painting asbestos cement building products
3548 : 1988	Code of practice for glazing in building (*first revision*)
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 water proofing 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
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 : 1983	Code of practice for laying of glazed stoneware pipes (*first 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	Choice of materials and general recommendations
(Part 2) : 1975	Laying and jointing polyethylene (PE) pipes
(Part 3) : 2003	Laying and jointing of unplasticized PVC pipes
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) : 1982	Formwork (*third revision*)
(Part 6) : 1974	Refactory work (*second revision*)
(Part 7) : 1972	Hardware (*second revision*)
(Part 8) : 1993	Steel work and iron work (*fourth revision*)
(Part 9) : 1973	Roof covering (including cladding) (*second revision*)
(Part 10) : 1973	Ceiling and linings (*second revision*)
(Part 11) : 1977	Paving, floor finishes dado and skirting (*third revision*)
(Part 12) : 1976	Plastering and pointing (*third revision*)

IS No.	*Title*
(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*)
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 : 1993	Code of practice for earthquake resistant design and construction of buildings (*second revision*)
4913 : 1968	Code of practice for selection, installation and maintenance of timber doors and windows
6313	Code of practice for anti-termite measures in buildings:
(Part 1) : 1981	Constructional measures (*first revision*)
(Part 2) : 2001	Pre-constructional chemical treatment measures (*second revision*)
(Part 3) : 2001	Treatment for existing buildings (*second 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
(2) 13416 (Part 5) : 1994	Recommendations for preventive measure against hazards at workplaces: Part 5 Fire protection
(3) 11769 (Part 1) : 1987	Guidelines for safe use of products containing asbestos: Part 1 Asbestos cement products

	IS No.	Title
(4)	2190 : 1992	Code of practice for selection, installation and maintenance of portable first-aid fire extinguishers (*third revision*)
(5)	8758 : 1993	Recommendations for fire precautionary measures in construction of temporary structures and pandals (*first revision*)
(6)	10439 : 1983	Code of practice patent glazing
	14687 : 1999	Guidelines for falsework for concrete structures
(7)	3764 : 1992	Safety code for excavation work (*first revision*)
(8)	4138 : 1977	Safety code for working in compressed air (*first revision*)
(9)	2925 : 1984	Specification for industrial safety helmets (*second revision*)
(10)	2750 : 1964	Specification for steel scaffoldings
(11)	3696 (Part 1) : 1987	Safety code for scaffolds and ladders: Part 1 Scaffolds
(12)	3696 (Part 2) : 1991	Safety code for scaffolds and ladders: Part 2 Ladders
(13)	4912 : 1978	Safety requirements for floors and wall openings, railing and toe boards (*first revision*)
(14)	11461 : 1985	Code of practice for compressor safety
(15)	1179 : 1967	Specification for equipment for eye and face protection during welding (*first revision*)
(16)	5983 : 1980	Specification for eye-protectors (*first revision*)
(17)	2361 : 2002	Specification for bull-dog grips (*third revision*)
(18)	11057 : 1984	Specification for industrial safety nets
(19)	3016 : 1982	Code of practice for fire precautions in welding and cutting operations (*first revision*)
(20)	1084 : 1994	Specification for manila ropes (*fourth revision*)
	2266 : 2002	Specification for steel wire ropes for general engineering purposes (*forth revision*)
(21)	818 : 1968	Code of practice for safety and health requirements in electric and gas welding and cutting operations (*first revision*)
(22)	5916 : 1970	Safety code for constructions involving use of hot bituminous materials
(23)	13416 (Part 4) : 1994	Recommendations for preventive measure against hazards at workplaces: Part 4 Timber structure
(24)	2171 : 1999	Specification for portable fire extinguishers, dry powder (Cartridge type) (*third revision*)
(25)	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 : 1986	Safety code for blasting and related drilling operations (*first 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)
(26)	3844 : 1989	Code of practice for installation and maintenance of internal fire hydrants and hose reels on premises (*first revision*)
	5290 : 1993	Specification for landing valves (*third revision*)

IS No.	*Title*
(27) 13416 (Part 2) : 1992	Recommendation for preventive measures against hazards at work places: Part 2 Fall prevention
(28) 13416 (Part 1) : 1992	Recommendation for preventive measures against hazards at work places: Part 1 Falling material hazard prevention
(29) 13416 (Part 3) : 1994	Recommendation for preventive measures against hazards at work places: Part 3 Disposal of debris
(30) 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 : 1985	Specification for batch type concrete mixers (*second revision*)
1930 : 1995	Specification for chisels and gauges (*second 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	Specification for heater for bitumen (tar) and emulsion (*second revision*):
(Part 1) : 1996	Specification (*second revision*)
(Part 2) : 1999	Bitumen sprayer (*third revision*)
(Part 3) : 1999	Emulsion (*third revision*)
2431 : 1963	Specification for steel wheel barrows (single wheel-type)
2438 : 1963	Specification for roller pan mixer
2439 : 1963	Specification for metal hand rollers (fixed-weight type)
2505 : 1992	Specification for concrete vibrators, immersion type (general requirements)
2506 : 1985	General requirements for screed board concrete vibrators (*first revision*)
2514 : 1963	Specification for concrete vibrating tables
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 : 1964	Specification for portable swing weigh batchers for concrete (single and double bucket type)
2852 : 1998	Specification for carpenters augers (*first revision*)
3066 : 1965	Specification for hot asphalt mixing plants
3251 : 1965	Specification for asphalt paver finisher
3365 : 1965	Specification for floor polishing machines
3559 : 1966	Specification for pneumatic concrete breakers

IS No.	Title
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*)
4057 : 1986	Specification for carpenters adjustable metal bodied bench planes (*first revision*)
4095 : 1991	Specification for pincers (*second revision*)
4183 : 1967	Specification for metal hand rammers
4184 : 1967	Specification for steel wheel barrows (with two wheels)
4508 : 1992	Specification for open ended slugging wrenches (spanners) (*first revision*)
4656 : 1968	Specification for form vibrators for concrete
4915 : 1968	Specification for welders chipping hammer
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 : 1994	Specification for vibratory plate compactor (*first revision*)
5890 : 1970	Specification for mobile hot mix asphalt plants, light duty
5891 : 1970	Specification for hand-operated concrete mixer
5995 : 1971	Specification for pipe grip pliers
6007 : 1971	Specification for pipe vices (hinged type)
6078 : 1986	Specification for line man's pliers (*second revision*)
6087 : 1971	Specification for metal cutting shears
6118 : 1991	Specification for multiple slip joint pliers (*first 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 : 1972	Specification for pile frame
6430 : 1985	Specification for mobile air compressor for construction purposes (*first revision*)
6433 : 1972	Specification for guniting equipment
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

IS No.	*Title*
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 : 1994	Specification for carpenter's wooden bodied planes (*first revision*)
8671 : 1977	Specification for nail puller
(31) 7293 : 1974	Safety code for working with construction machinery
(32) 15183 (Part 3) : 2002	Maintenance management for buildings — Guidelines: Part 3 Labour
(33) 15183 (Part 2) : 2002	Maintenance management for buildings — Guidelines: Part 2 Finance
(34) 13935 : 1993	Guidelines for repair and seismic strengthening of buildings
(35) 13828 : 1993	Improving earthquake resistance of low strength masonry buildings — Guidelines
(36) 13827 : 1993	Improving earthquake resistance of earthen buildings — Guidelines
(37) 4130 : 1991	Safety code for demolition of buildings (*second revision*)